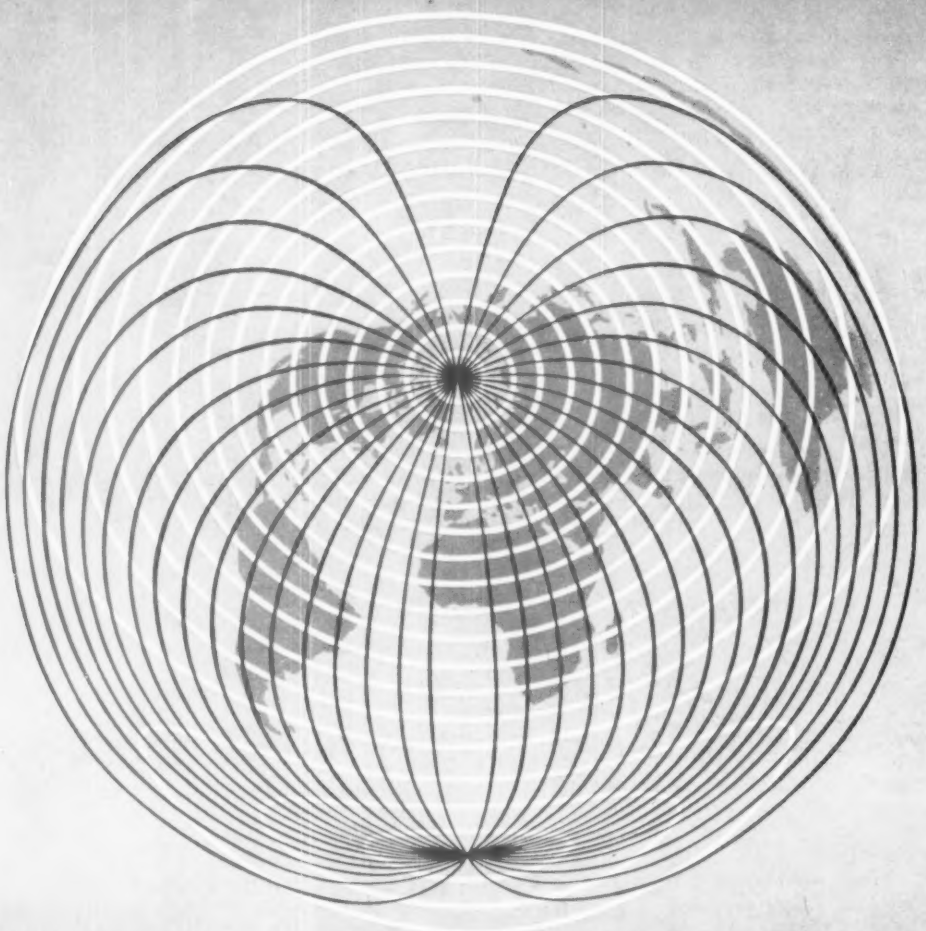
Wireless World

MARCH 1953 · TWO SHILLINGS



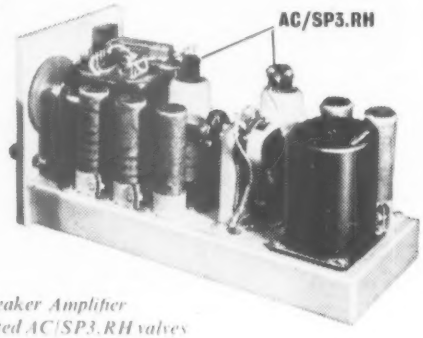
RADIO, TELEVISION AND ELECTRONICS

the B.B.C. make wide use of this valve

The Ediswan Mazda AC/SP3.RH is an indirectly heated Pentode with a special heater construction designed to reduce hum due to A.C. fields within the valve. Its high working slope makes it very suitable for use in audio frequency stages employing negative feed back.

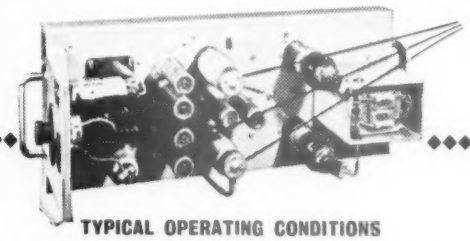
The high-slope short grid-base characteristic renders it suitable also as an harmonic generator and as an oscillator in high stability crystal drive equipment. Provided precautions are taken to minimise hum due to external wiring the AC/SP3.RH may also be successfully employed in the early stages of amplifiers where the reduction of hum, noise and microphony is of primary importance.

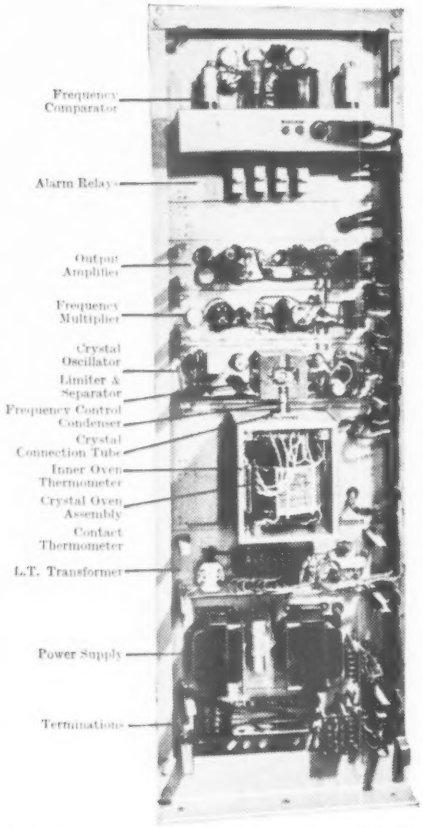
Many of these valves have been supplied to the British Broadcasting Corporation for use in their special recording, amplifying, and crystal controlled precision drive equipments, some of which are illustrated on this page.



B.B.C. Type D. Recorder Line Amplifier LFA/1 using two pentode connected AC/SP3.RH valves

B.B.C. Type D. Recorder Loudspeaker Amplifier LSM/7 using three pentode connected AC/SP3.RH valves





B.B.C. Crystal Drive Equipment (Type CP-17E) using nine AC/SP3.RH valves in the crystal maintaining amplifier, frequency divider, frequency multiplier and oven temperature relay.

TYPICAL OPERATING CONDITIONS

Anode Voltage (Va)	250	250	250	250
Screen Voltage (Vg2)	80	100	160	200
Grid Bias (Vg1)	1.25	1.7	2.75	3.5
Anode Current (mA)	7.8	7.9	10.5	12.3
Screen Current (mA)	2.45	2.5	3.3	3.85
Mutual Conductance (mA/V)	7.0	7.0	7.45	7.6
Anode AC Resistance (ra) (Meg ohms)	0.55	0.55	0.4	0.3
Input Capacity (Hot) (μμF)	20	19.9	19.7	19.5

RATING

Heater Voltage	V_h	4.0
Heater Current (Amps)	I_h	1.0
Maximum Anode Voltage	V_a	250
Maximum Screen Voltage	V_{g2}	250
Mutual Conductance (mA/V)	g_m	7.7

Taken at $V_a = 250$; $V_{g2} = 100$; $V_{g1} = 1.5$

BASE

British 7 pin

Pin No. 1 Metallising
Pin No. 2 Anode
Pin No. 3 Suppressor Grid (G3)
Pin No. 4 Heater
Pin No. 5 Heater
Pin No. 6 Cathode
Pin No. 7 Screen (G2)
Top Cap Control Grid (G1)

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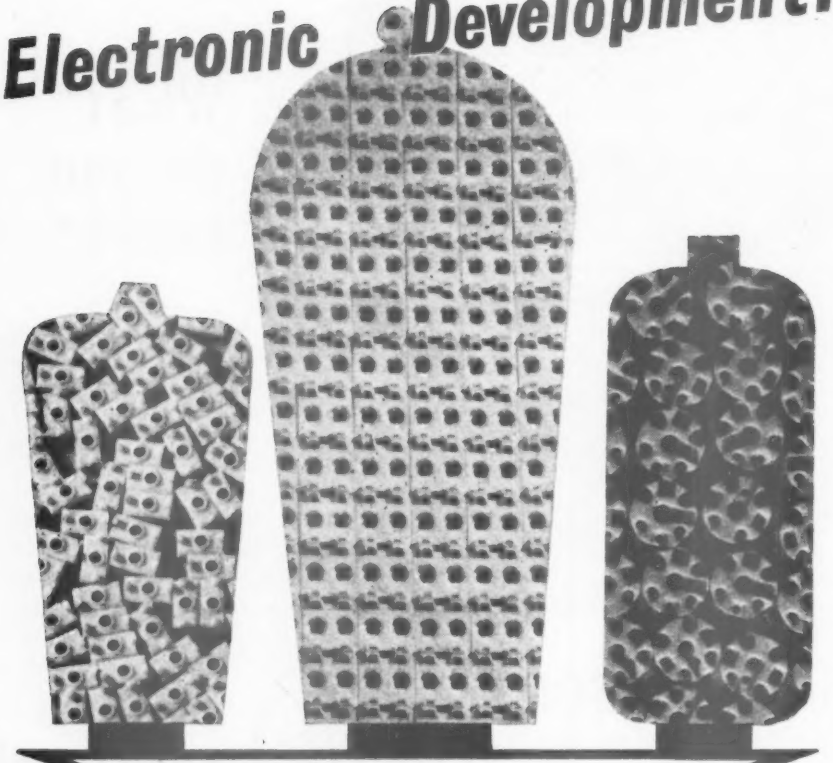

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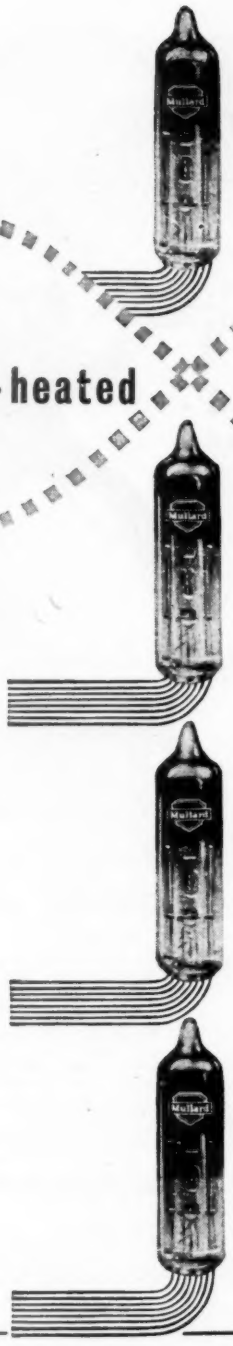

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The electrical performance of these subminiatures is equal to, and in certain cases even better than, that expected from valves of a much greater size. The EF72 R.F. amplifier, for example, which is suitable for use in the first stage of telecommunications receivers, combines many of the qualities of larger low-noise receiver input valves, with the ability to work at higher frequencies.

To enable experimental and development work to be carried out with these indirectly-heated subminiatures, a limited number of samples can be made available now. Designers who require further information are advised to send their enquiries to the address below as soon as possible.

Type No.	Description	Filament or Heater (V)	Filament or Heater (mA)	$V_a = V_{g2}$ (V)	$-V_{g1}$ (V)	I_a (mA)	I_{g2} (mA)	g_m (mA/V)
EA76	Single diode (5 mm. bulb)	6.3	150	150 (max.)	—	9.0 (max.)	—	—
EC70	U.H.F. triode oscillator	6.3	150	100	2.0	13	—	5.5
EF70	High slope R.F. pentode with short suppressor grid base	6.3	200	100	2.0	3.0	2.5	2.5
EF71	Variable-mu R.F. pentode	6.3	150	100	1.2	7.2	2.2	4.5
EF72	High slope R.F. pentode	6.3	150	100	1.4	7.0	2.2	5.0
EF73	High slope pentode for industrial applications	6.3	200	100	2.0	7.5	2.5	5.25
EY70	Half-wave rectifier	6.3	450	250 (max.)	—	45 (max.)	—	—
DY70	High voltage rectifier (directly heated)	1.25	140	10KV (P.I.V.)	—	2.0 (max.)	—	—

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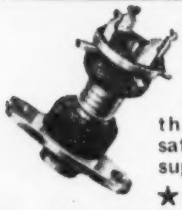

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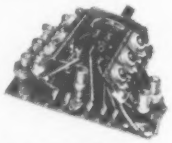

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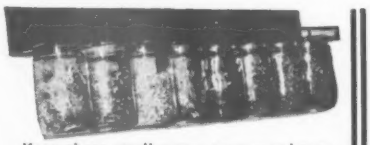

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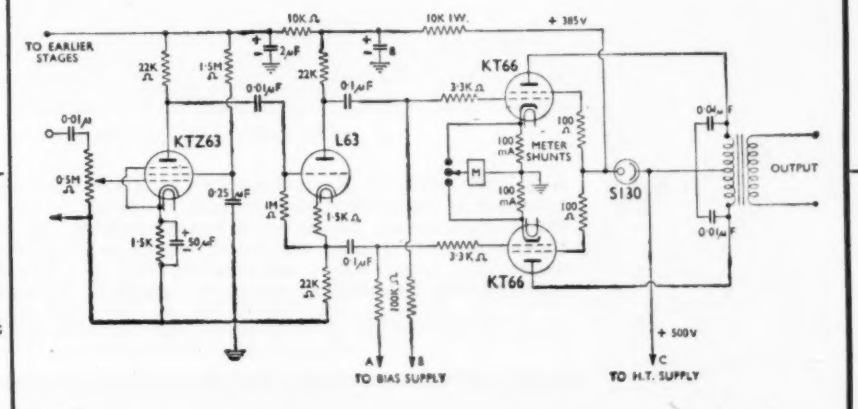

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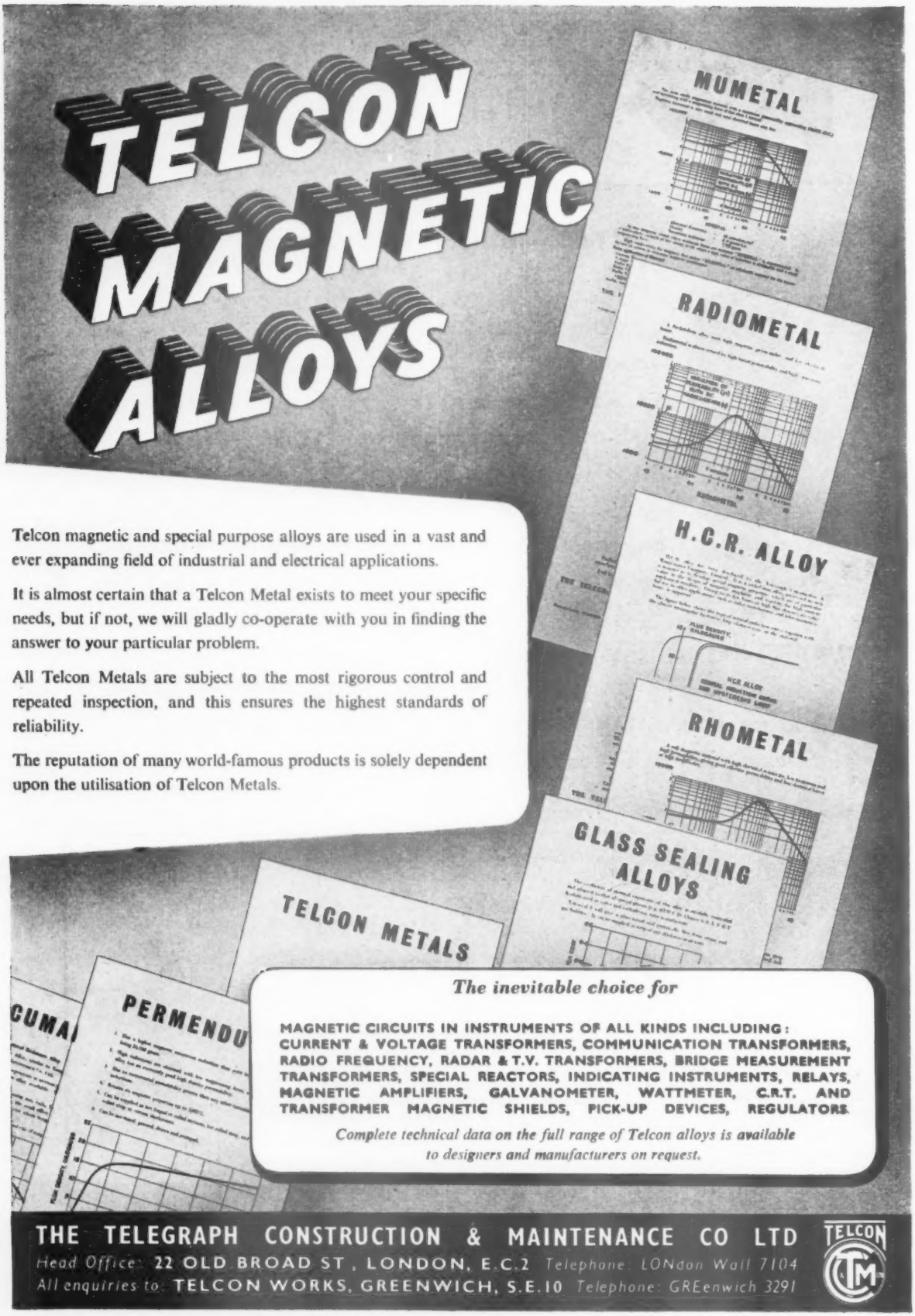

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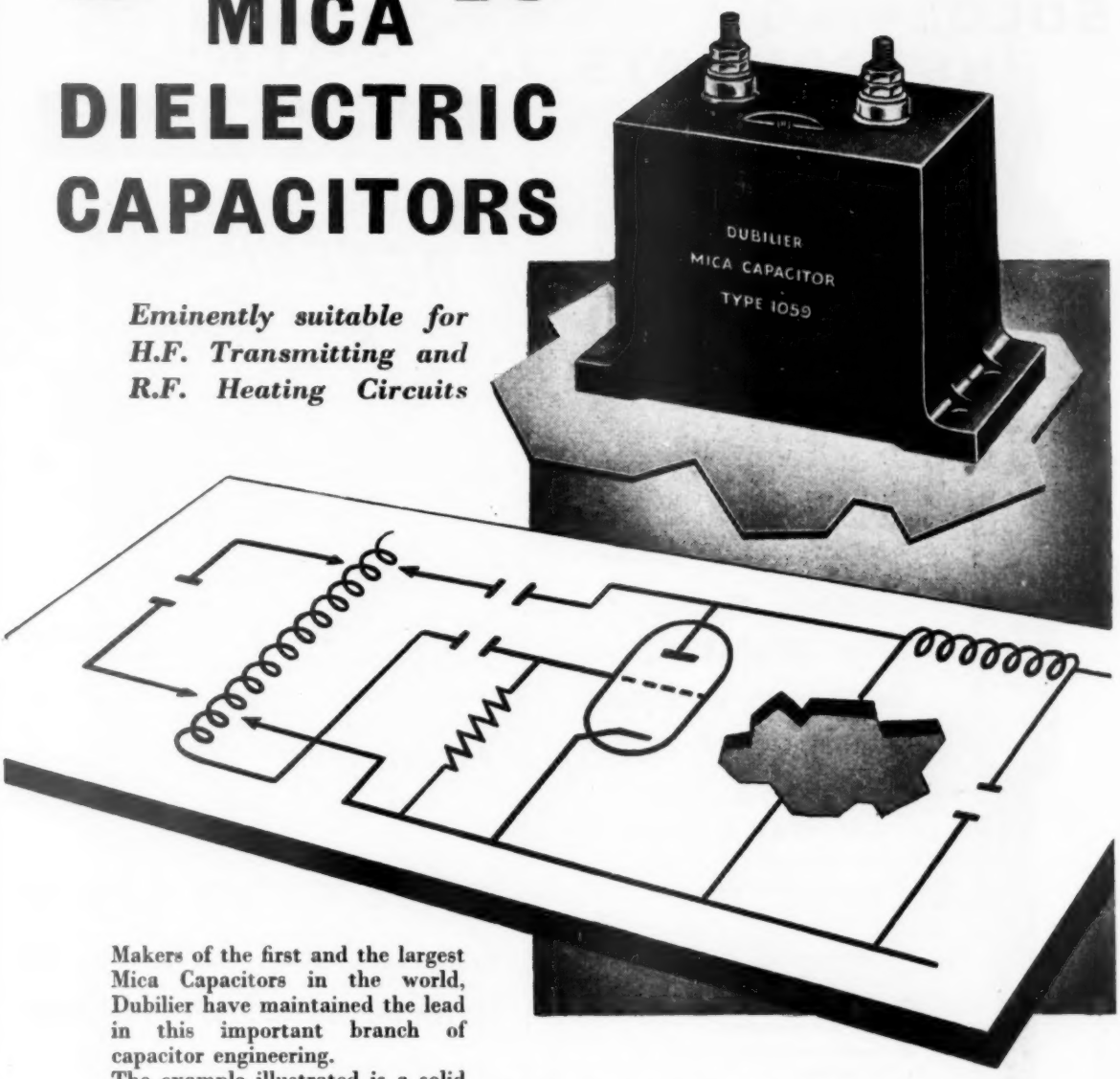

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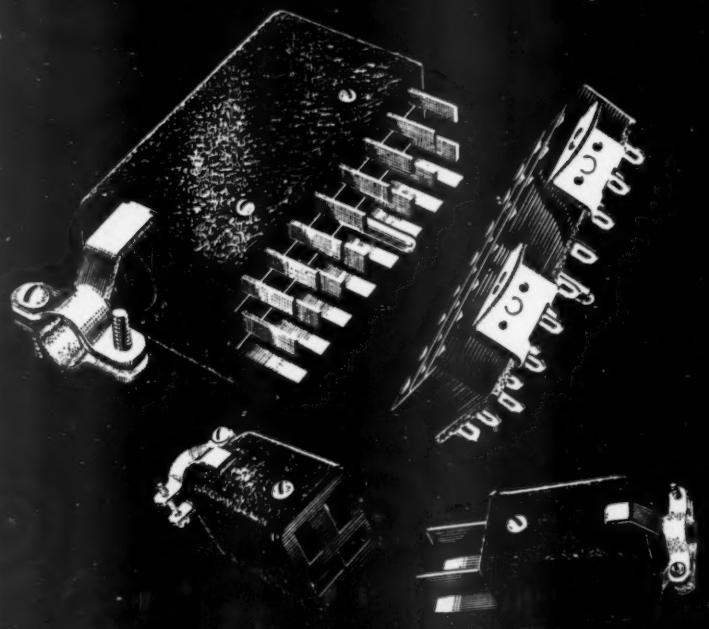

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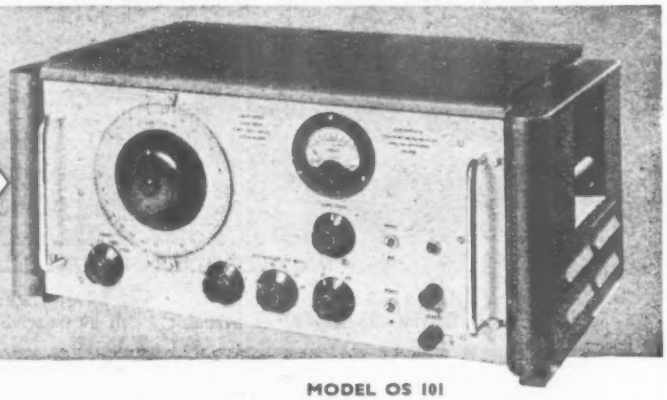

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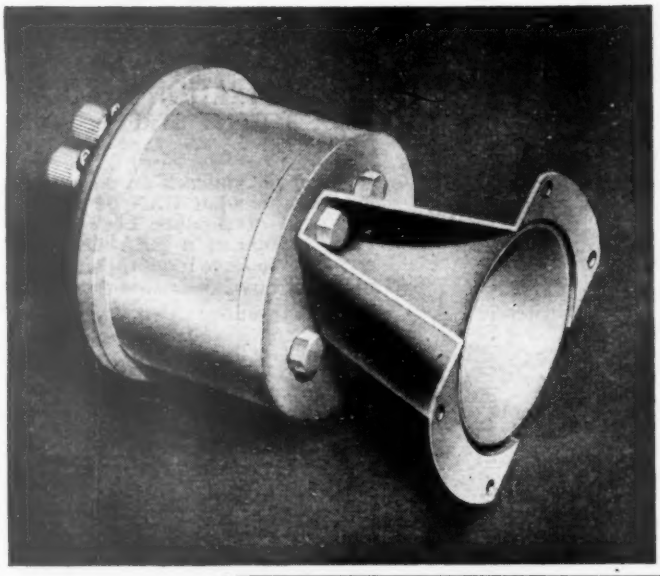

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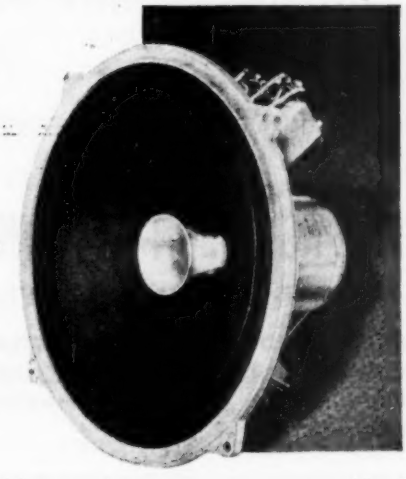

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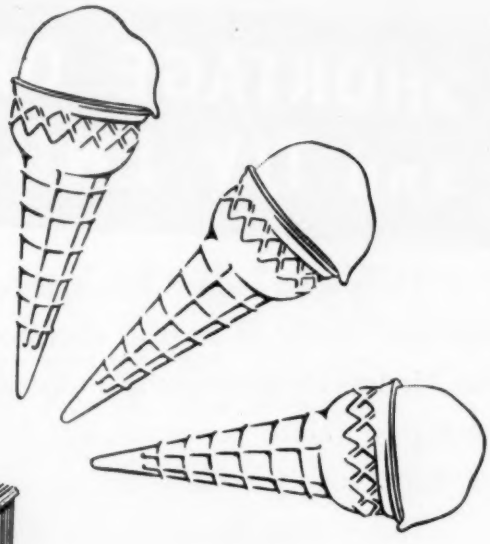

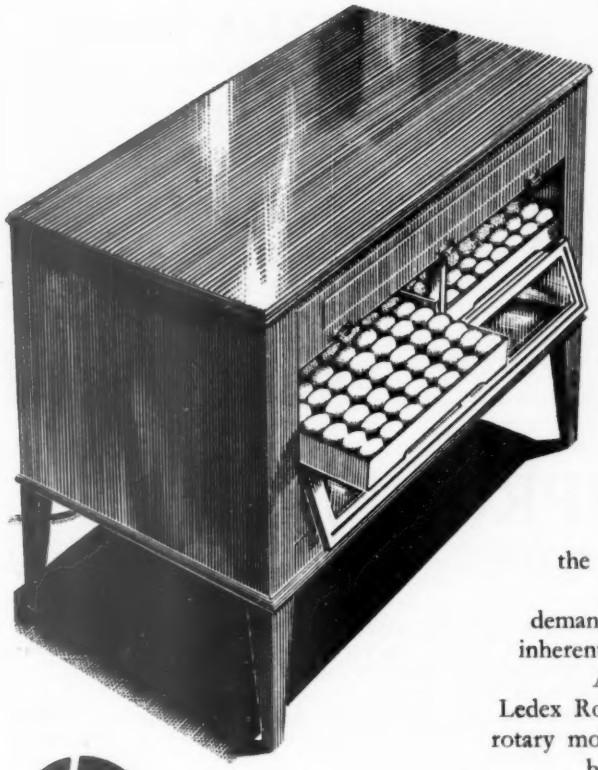

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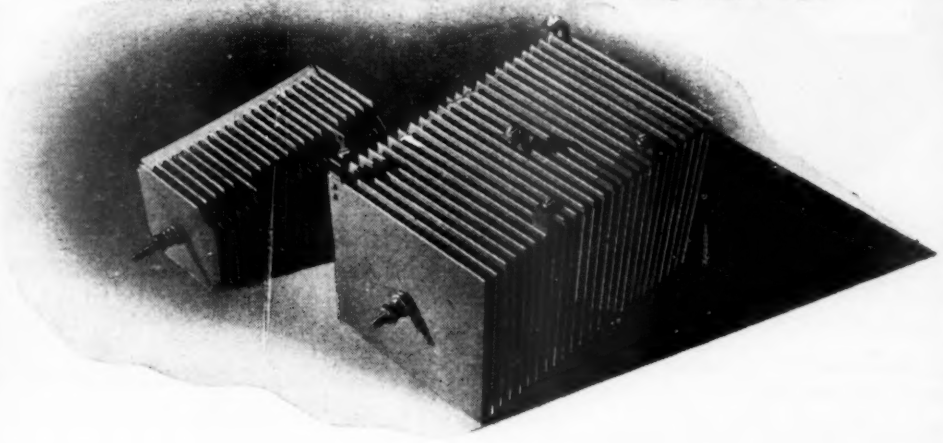

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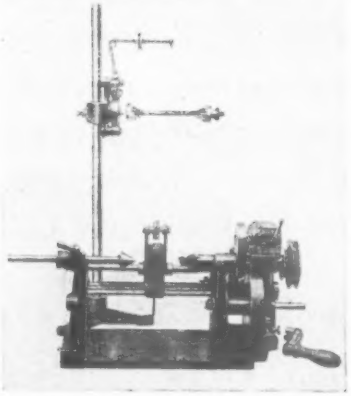

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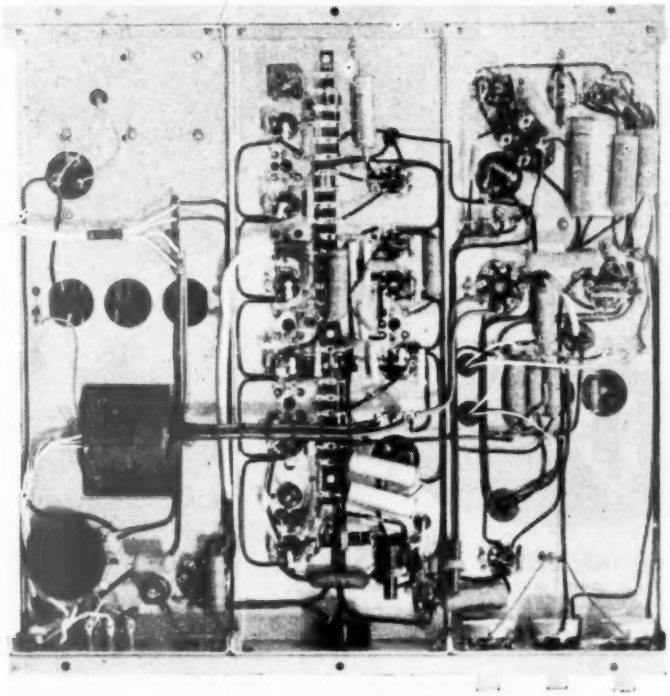

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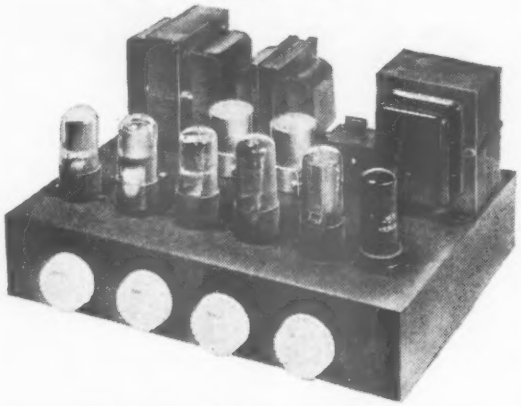

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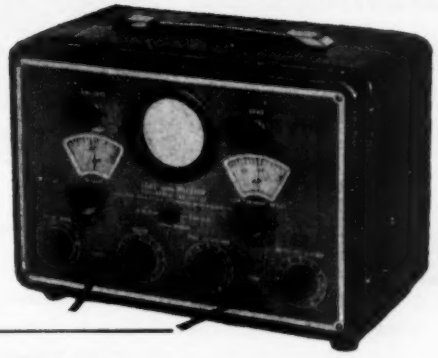

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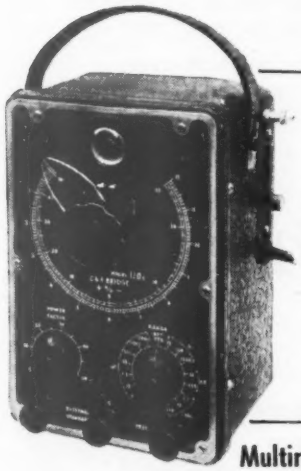

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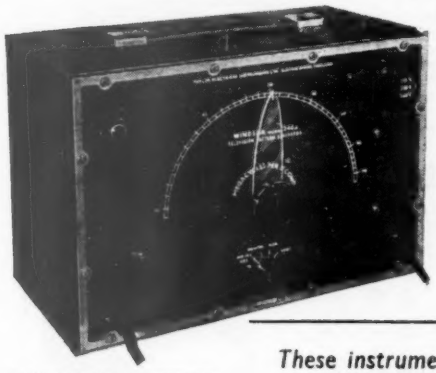

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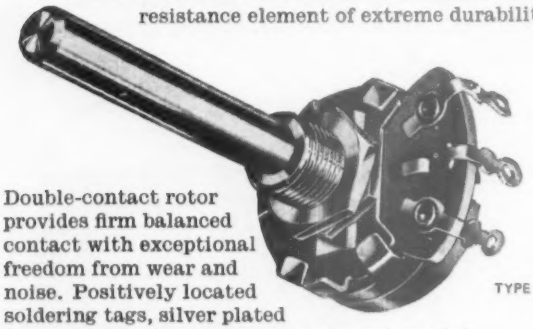
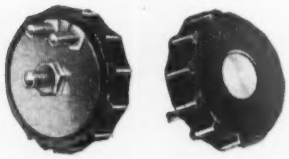


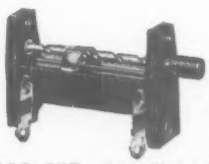
TYPE 105

Double-contact rotor provides firm balanced contact with exceptional freedom from wear and noise. Positively located soldering tags, silver plated for easy soldering. All steel parts rustproofed. Standard resistance values available, from 5000 ohms to 2 megohms.

Type 115 is identical to Type 105 except that a 2-pole Q.M.B. switch is incorporated.



SUB-MINIATURE VOLUME CONTROLS For use in Deaf Aids and other miniature electronic apparatus



PRE-SET RESISTORS A wire-wound pre-set resistor for panel or chassis mounting

Export enquiries welcomed

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POTENTIOMETERS

EGEN ELECTRIC LTD., CHARFLEET INDUSTRIAL ESTATE, CANVEY ISLAND, ESSEX. PHONE: CANVEY 691-2

Announcing the

SCALAMP ELECTROSTATIC VOLTMETER

Cat. No. W.W. 11310

DIRECT READING.

ZERO CURRENT DRAIN.

THREE SECONDS PERIOD.

LAMP OPERATES FROM MAINS OR 4 VOLT BATTERY.

BRIGHT SPOT-AND-HAIRLINE INDICATOR.

This instrument introduces a completely new conception of electrostatic voltmeter. It is compact, portable and robust, and does not require critical levelling or special mounting. The movement has a taut suspension, is critically damped, and readings can be taken with rapidity and ease. Three models are available:

Cat. No. W.W. 11308 1 - 5 kV A.C. D.C.

Cat. No. W.W. 11309 3 - 10 kV A.C. D.C.

Cat. No. W.W. 11310 5 - 18 kV D.C. and 5 - 12 kV A.C. R.M.S.

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W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE

A workshop in your pocket! FOR ONLY **25'6** POST FREE

THE TELEVISION AND RADIO SERVICE ENGINEER'S **MASTER** TRIMMER KIT

CONTAINS

1 End Trimmer ● 1 Side Trimmer ● 1 Yaxley Switch Contact Adjuster ● 1 Low Capacity Trimmer ● 1 Screwdriver ● 1 Set of Feeler Gauges ● 1 Set of six Box Spanners from 1 to 8 B.A. ● 1 Set of four Spanners from 0 to 8 B.A. In durable black crackle finish metal case.

WELDED RADIO CHASSIS

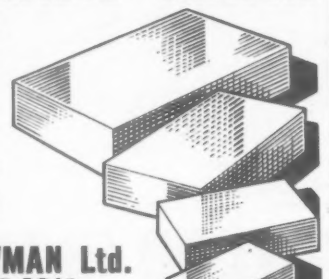
Aluminium Chassis 18 S.W.G., Welded corners for added strength. Highest quality manufacture.

6" x 4" x 2½" ..... **4'9**

8" x 6" x 2½" ..... **6'-**

10" x 7" x 2½" ..... **6'9**

12" x 8" x 2½" ..... **8'6**



Trade supplied :

J. & S. NEWMAN Ltd.

100 HAMPSTEAD ROAD, LONDON, N.W.1

Telephone - - - EUSton 5176/7

An important Announcement by..

THE MASTER SOUND SYSTEM

THE M.S.S. RECORDING CO. LTD. have pleasure in announcing the immediate production in quantity of an entirely new conception of Tape Recorder to be known as the PMR/3. This new model will be available at a truly competitive price compatible with the high quality performance always associated with the name M.S.S. Large Government orders, placed prior to production, must necessarily occasion some delay in meeting other demands, but every endeavour is being made to step up production.
The following brief features, coupled with the M.S.S. world wide reputation for reliability, will indicate the many advantages of this machine.

THE TYPE PMR/3 MAGNETIC TAPE RECORDER

This Recorder incorporates an entirely new design based on experience gained over a number of years in the supply and manufacture of professional disk and magnetic recording equipment, and is intended for general and professional application. The standard portable model has the following outstanding features—

Low weight consistent with rugged construction.

Dual speed 7½" and 3¾" per second. Due to the use of a large fly-wheel and capstan, turned and ground to precision limits, wow and flutter are very low at both speeds.

Special design of drive motor ensures minimum variation of speed both whilst warming up and as a result of voltage variation.

Powerful take-up motors provide complete rewind or wind forward in one minute.

Simplicity of operation. Tape drops in slot in head assembly. Single knob controls all functions: record, replay, fast forward, and rewind.

Instantaneous change from 7½" to 3¾" per second.

Magic-eye indicator ensures accurate setting of recording level.

Half-track recording giving total playing time of one hour at 7½" per second and two hours at 3¾" per second.

High quality amplifier. Output 3 watts.

Overall frequency response
60-10,000 c.p.s. ±3 db at 7½"/sec.
70- 7,000 c.p.s. ±3 db at 3¾"/sec.

Less than 2½% total harmonic distortion at normal operating level.

A.C. erase head giving low noise level.

Signal-to-noise ratio greater than 45 db.

Dimensions 16" wide x 11" high x 18" deep approx.

Weight 45 lbs. approx.

Case covered in high grade leather cloth with compartment for all accessories and built-in loudspeaker.

●

Fuller details will be announced later.

● *The Tape Player itself is of unit construction which enables many special requirements and applications to be met without undue modification. The following features can be provided to special order—*

Tape speeds 7½" and 15" per second, or 3¾" and 1⅞" per second.

●

Synchronous drive motor.

●

Remote operation or foot control.

●

Automatic back spacing and reverse drive for dictation purposes.

●

Cassette tape loading.

●

Rack mounted assembly.

M·S·S RECORDING COMPANY LTD
POYLE CLOSE · COLNBROOK · BUCKINGHAMSHIRE · TELEPHONE · COLNBROOK 284

MODEL PW50 (4ft. x 3ft.) PROJECTOR CONSOL

In a fine walnut or metal cabinet, the projector is sold exclusive ofscreen. (Walnut model illustrated below). **PRICE £157 10s.**

NERA ACTIVATED SCREENS

These scientific screens for use with either television or ciné projectors, are designed to reflect light from a controlled angle with very high efficiency. Whatever type of projector used the Nera screen will give brighter pictures than ever before achieved, maintaining high contrast ratios even in normal room lighting.

PRICES from £8.

MODEL C30. In a beautiful cabinet of neat proportions, is a complete projection receiver, including screen, giving a sensational large picture 30in. wide. **PRICE £264,** inc. P.T.

Overseas models available. Trade & export enquiries invited.

MODERATE IN PRICE . . .

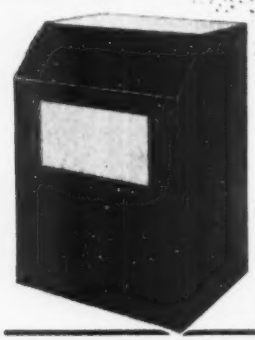
OUTSTANDING IN DESIGN . .

BRILLIANT IN PERFORMANCE

NERA
4'x3' T/V

CHOSEN BY THE B.B.C.

for entertaining large audiences, two Nera Projectors catered for 1,000 people in the Television Studio at the 1952 Radio Show. Nera Projectors are being used by the B.B.C. on many similar occasions.



INCORPORATING THE EXPERIENCE OF THREE YEARS FIELD TESTING

● **STEADY PICTURE—NO 'BOUNCE' OR 'BALLOONING'**
The special circuit technique eliminates picture 'bounce' on scene changes or interference pulses.

● **ARMCHAIR REMOTE CONTROL**
The illuminated remote panel gives complete control over Contrast, Brilliance, Focus and Sound Volume from your armchair.

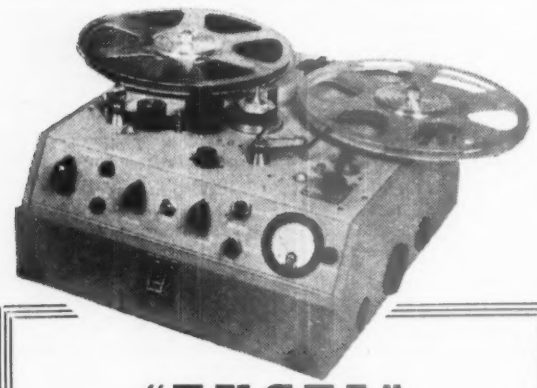
● **AEROPLANE FLUTTER FILTER**
The annoying effects usually associated with aircraft have been almost entirely eliminated.

● **VIEWING IN NORMAL ROOM LIGHTING**
The special Nera screens give maximum reflected light and, when suitably positioned, subdued room lighting is quite unnecessary.

● **OUTSTANDING DEFINITION & LINEARITY**
The Nera receiver has been carefully designed to give a faithful reproduction of the transmitted image.

● **HIGH FIDELITY SOUND OUTPUT**
A push-pull output stage feeds twin speakers via a cross-over network.

AREN (RADIO & TELEVISION) LTD., HIGH ST., GUILDFORD, SURREY. Telephone : GUILDFORD 67222/3



"EXCEL"
MAGNETIC TAPE RECORDERS

Although designed primarily for high quality synchronised sound with sub-standard film projectors, the EXCEL is used as a first class recorder for high fidelity work.

- WIDE FREQUENCY RESPONSE
- FREEDOM FROM "WOW" AND FLUTTER
- 10½in. DIAMETER FLYWHEEL
- SUPERIMPOSING
- NOISE SUPPRESSION
- TAPE CAPACITY : Standard 3250 ft. single sided spools and NAB 2400 ft. double sided spools.
- PORTABLE. WIDTH 14½in. DEPTH 17½in. HEIGHT 8½in.

For full details and nearest Agent please write to

EXCEL SOUND SERVICES LTD.
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EDG 1143/44 Estd. over 30 years.
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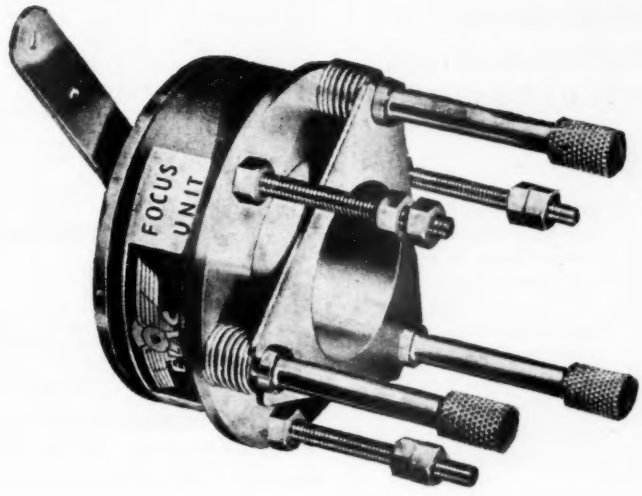

TELEVISION COMPONENTS

MARK II SERIES
"THIN LENS"

P.M. Focus Units provide even focus over the whole tube face giving accurate picture positioning and easy vernier focus adjustment.

TYPE R17/MK.II	for	MULLARD	MW 22-16, MW 31-16, etc.	28/6 LIST
TYPE R20/MK.II	for	BRIMAR	C9B FERRANTI T92, T122, etc.....	30/- LIST
TYPE R25/MK.II	for	MAZDA	CRM 121, etc.	32/6 LIST
TYPE W20/MK.II	for	MULLARD	MW 36/22	50/- LIST
TYPE W22/MK.II	for	MULLARD	MW 41/1 ENG. ELEC. T.901	52/6 LIST
TYPE W25/MK.II	for	BRIMAR	C14 BM, C17 BM.....	57/6 LIST

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(Trade Mark)

Because It Has
- HIGH GAIN
- BROAD BANDWIDTH
- CORRECT MATCHING
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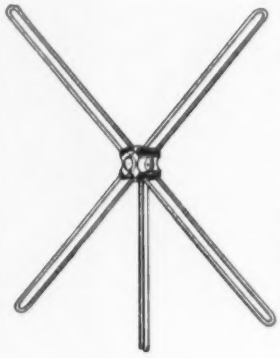
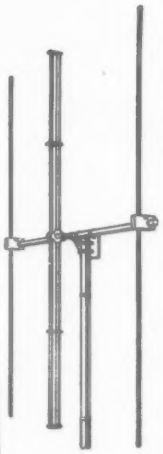


these features, PLUS excellent mechanical design, ensure that you get the best performance from your receiver. Moreover, the Dublex is moderately priced at **£4.8.6** (7ft. mast complete with brackets, etc.); **£7.15.0** (10ft. x 2in. mast complete with double lashings, etc.).

. . other quality aerials

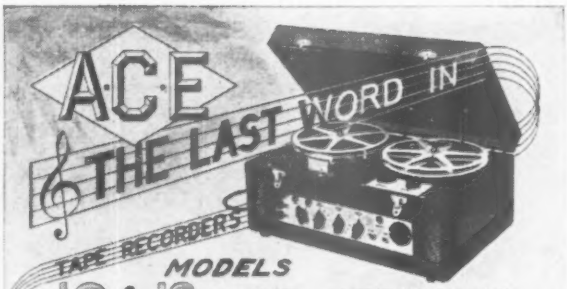
in the comprehensive Aerialite range include the AERFRINGE and AERADOOR models: 8.0dB forward gain, sharp directivity for interference elimination and broad bandwidth for greater detail. Model 63A complete with 10ft. mast, double lashings, etc. price **£13.15.0.** The room-mounting AERADOOR model 65 has a telescopic top element and is suitable for all channels. Price **£1.12.0** complete.



NEWCASTLE and BELFAST TRANSMITTERS—
the Dublex is available with a special horizontal mounting bracket for reception of these stations and most other Aerialite aerials can be used without modifications.

● Manufactured by Aerialite Ltd., Castle Works, Stalybridge, Cheshire.

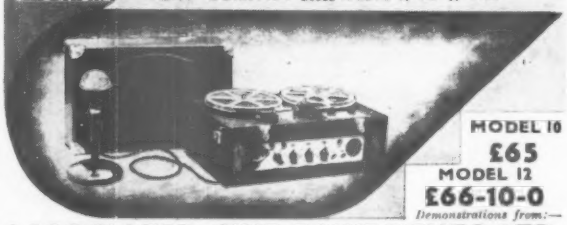
AERIALITE Aerials



MODELS 10 & 12 HAVE EVERYTHING

10 WATTS PUSH-PULL HIGH FIDELITY AMPLIFIER
3 INPUTS: CRYSTAL & M/C. MICS. & GRAM.
3 TAPE SPEEDS: 3¾, 7½ & 15 INCHES PER SECOND
2 TRACKS PER TAPE – 2 Hrs. RECORDING
2 SEPARATE INPUT CONTROLS FOR MIXING
COMPLETELY AUTOMATIC ERASE (ELECTRONIC)
DETACHABLE SPEAKER UNIT MODEL 12
FAST REWIND & FORWARD WIND
MONITORED & DIRECT INPUTS
VERY COMPACT MODEL 10 15½" x 10" x 7¾"

SEND STAMP FOR FULLY ILLUSTRATED BROCHURE



MODEL 10 **£65**
MODEL 12 **£66-10-0**
Demonstrations from:—

ASSOCIATED CINE EQUIPMENTS LTD.
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The RD JUNIOR CORNER HORN

This entirely new and original design is compact in size, features horn loading for bass and wide angle diffusion of treble, which, together with the general design of the cabinet, results in reproduction which has perspective, is forward and achieves an unusual degree of "presence." Horn loading results in very "clean" and extended bass response, free from objectional coloration.
Moderately priced, it brings a really high standard of reproduction within reach of the majority of music lovers.
Available in any finish. PRICE **£20 0 0**

Recommended Loudspeakers :—
Goodmans Axiom 102 ..... £10 14 1
Goodmans Axiom 101 ..... £7 2 9
Wharfedale SUPER 8 AL. £6 9 11

The RD MINOR BAFFLE

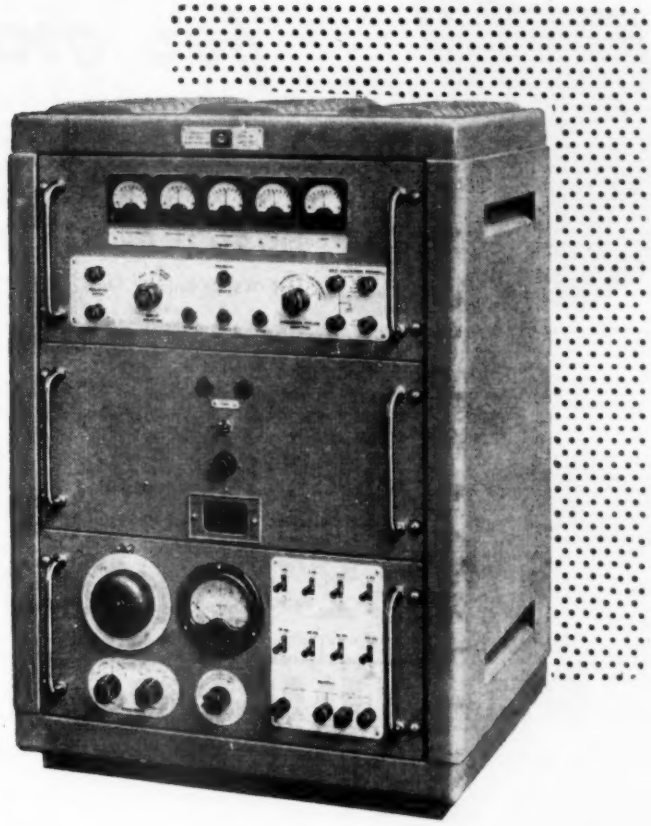
A new design of pleasing appearance, designed to house good quality 8in. or 10in. loudspeakers. Available at present in Walnut finish only. PRICE **£8 15 0**

Recommended Loudspeakers :—
RD High-flux 8in. Unit £3 5 0
Wharfedale 10in. Bronze £5 0 4

Detailed specifications of both cabinets available on request.
Available from leading dealers in London and the Provinces, or if in any difficulty, please apply direct.
Trade enquiries invited.

ROGERS DEVELOPMENTS CO
"Rodeveo House," 116 Blackheath Road, Greenwich, London, S.E.10. Telephone: TIDeway 1723

R. C. OSCILLATOR AND AUTOMATIC FREQUENCY MONITOR



An instrument of exceptionally high accuracy and stability—the output frequency of which is automatically measured and presented in decimal notation.

Range	10c/s to 100kc/s
Accuracy	±0.005%
Output	0 to 30 volts r.m.s. metered
Attenuator	0 to 110db in 1db steps (constant 600Ω)

The equipment will measure any frequency in the range 10c/s to 100kc/s and any time in the range 10μsec to 10^4sec both to an accuracy within ±0.005%. It will also count up to a maximum rate of 10^5 pulses/second.

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A Company within the J. Arthur Rank Organisation

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BURGOYNE

DUAL TRACK TRANSPORTABLE TAPE RECORDER

We are proud to offer to-day's greatest value in tape recording. Now being demonstrated at the Radio Centre.

- ★ 64 mins. playing time from a standard 7in. reel—dual tracks.
- ★ Fast forward and rewind.
- ★ Instantaneous braking of tape reels.
- ★ Record Playback changeover switch with visual indication of position.
- ★ Supplied with Ronette high-fidelity crystal microphone.
- ★ Frequency response 30-9,000 c/s at 7½in. per second.

Three heavy duty motors to obviate use of friction drives. Erase and bias frequency 50 Kc/s. Power consumption approximately 80 watts. Output 4 watts. All controls and inputs mounted on front of cabinet on handsome escutcheon plate. Bass treble controls for cut and boost operative on both record and playback. Separate radio and microphone inputs.
All accessories available separately as advertised.

Speaker muting switch obviating feedback between microphone and speaker. High-grade P.M. speaker. Extension speaker sockets. Switching provided for use of amplifier for high-quality reproduction. Handsome polished walnut cabinet, overall dimensions 21in. × 13in. × 13in.
We recommend high coercivity tape by Burgoyne for use in this recorder. 1,200ft. spool, 35/-; 600ft. spool, 21/-.

Price 32 gns. With crystal microphone. Or H.P. terms, £11/4/- deposit and 12 monthly payments of 42/9. Carriage and packing, 21/-.

DON'T TAKE OUR WORD FOR IT — COME AND *HEAR* THIS AMAZING INSTRUMENT

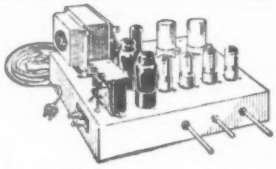
THE GRUNDIG REPORTER TAPE RECORDER

—always in stock

SPECIFICATION. Push button control; revolutionary design of plug-in recording, reproducing and erasing heads giving a recording range flat within ±3 db. from 50-10,000 c.p.s. Silent fast forward and rewind; twin track recording giving over one hour's recording from one reel of tape; separate sockets for microphone, radio, recording from disc and remote control; provision for monitoring; tone and volume controls; suitable for A.C. operation only, 105 to 250 volts; self contained; complete with built-in loud-speaker; coloured morocco finished portable case with ivory instrument panel and gilt locks. Weight 33lb. approx. Valve line-up: EF40, ECC40; EL42 (Output), EL42 (Oscillator) and EM34 (Magic Eye).

Price £78.15s. H.P. terms available. Send 33⅓ per cent. as deposit. Balance may be spread over 12 or 18 months as desired.

M.O.S. QUALITY GRAND AMPLIFIER KIT



Because of its excellent performance and thorough reliability, this Amplifier is in greatest demand. It has been designed for the connoisseur at a price within the reach of all.

- ★ Wide range; continuously variable treble and bass controls which give both boost and cut about a mean reference level at 1,000 c/s.
- ★ Heavy Neg. feedback used over the stages after the equaliser circuits ensuring that action of the tone control is unimpaired by following amplifier stages.
- ★ No harmonic distortion.
- ★ 7 Valves.
- ★ Two inputs.
- ★ For use on A.C. mains.

- ★ Type A 6v6/6v6 output **£9/19/6** Cash or £3 deposit
  Kit and 12 monthly payments of 15/-.
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  Kit Deposit and 12 monthly payments of 16/8.
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- ★ Quality Grand Manual only 4/6.

We specialise in issuing an instruction manual in such a form that construction of the kit is simple and straightforward. Profuse illustrations and diagrams of point to point wiring are provided and the constructor just cannot go wrong.

We have a range of Kits always available. Send for manual first. (Cost refunded if Kit purchased.)

Type					
A1	4 watt A.C.	Amplifier	Manual	.....	3/6
A2	3 watt A.C./D.C.	,,	,,	.....	3/-
A3	Quality Grand	,,	,,	.....	4/6 (as above)
A4	Record/Playback Tape	,, (4 valve)	,,	.....	3/9
A5	,, ,, ,,	,, (14 valve)	,,	.....	5/-
RF1	Radio Feeder Unit	,,	,,	.....	2/-

M·O·S

ALWAYS IN STOCK:- RONETTE MINIWEIGHT CRYSTAL PICKUPS FOR HIGH-FIDELITY RECORDINGS.

B S R GRAMOPHONE MOTORS AND TURNTABLES—A TYPE FOR YOUR EVERY NEED!

E & G **MAIL ORDER SUPPLY CO.**, *The RADIO CENTRE*
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The RONETTE "CORONATION"

HIGH FIDELITY CRYSTAL MICROPHONE

★ A new Ronette Microphone particularly recommended for magnetic tape recording.

★ Suitable for either hand or desk use.

★ Fitted with type DX12 insert giving a frequency response between 30-13,000 c/s. This insert is vacuum sealed, precision ground and optically inspected.

★ Housed in highly polished black plastic moulding with long connecting lead.

★ The most attractively priced microphone on the market, giving a far superior performance

★ Output at 1,000 c/s 1.3 MV/μBAR.

★ Fitted with annealed, corrosion resistive aluminium diaphragm.

★ Stands 17/6 extra.

ONLY 52/- post free

INTRODUCING ANOTHER HIGH FIDELITY CRYSTAL MICROPHONE!

STREAMLINED TILTING HEAD MICROPHONE TYPE "G210" *with "Filtercel" insert.*

A new RONETTE microphone of most appealing design. Chromium-plated die-cast alloy housing swivelling 100° for semi- or omni-directional use. A slim beauty of exceptionally fine appearance. Can be supplied with or without an on-off switch.

PRICE £4:19:6 H.P. terms 29/6 deposit, 12 monthly payments of 9/-. Built in on/off switch 20/- extra.

TECHNICAL SPECIFICATION: Effective output level at 1,000 c.p.s. 2.6 mV/μBar in 5 MOhms. Frequency response: 30–7,500 c.p.s. Output impedance: equal to 2,200μμF. Directional characteristic: In normal position semi-directional. Swivelled backwards omni-directional. Diaphragm: annealed corrosion-resistive aluminium. Crystal-unit: vacuum sealed, precision ground, and optically inspected. Case: streamlined case of die-cast alloy. Finish: chromium plated. Dimensions overall: Diameter: 52 mm. Height: 105 mm. Depth: 80 mm.

Similar model available with built-in low-impedance transformer for use with long connecting lines, e.g., in public address equipment **£6/19/6.**
H.P. terms 39/6 deposit, 12 monthly payments of 11/6.

The DISTINGUISHED Type "RFC" STUDIO MICROPHONE

with *Fully Floating* insert.

This Ronette microphone has the casing of its bigger relatives, known as STUDIO-CELL-UNIT MICROPHONES. The "RFC" has very fine contours and beautiful finish together with high quality.

TECHNICAL SPECIFICATION: Effective output level at 1,000 c.p.s. 2.6 mV/μBar in 5 MOhms. Frequency response: 30–7,500 c.p.s. Output impedance: equal to 2,200 μμF. Directional characteristic: semi-directional. Diaphragm: annealed corrosion-resistive. Crystal-unit: aluminium vacuum-sealed, precision ground and optically inspected. Case: wire-gauze screen fitted in frame. Finish: Chromium-plated frame and glossy black baked wire-gauze casing, fitted to chromium-plated saddle. Dimensions overall: Height: 170 mm. Width: 95 mm. Depth: 53 mm.

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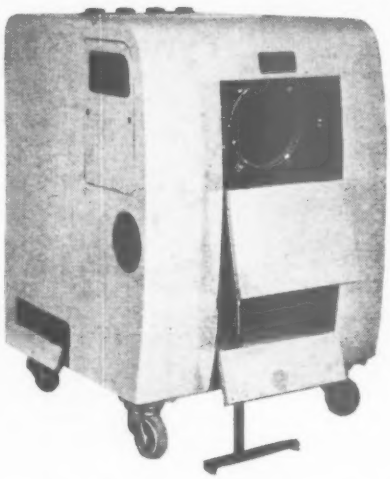

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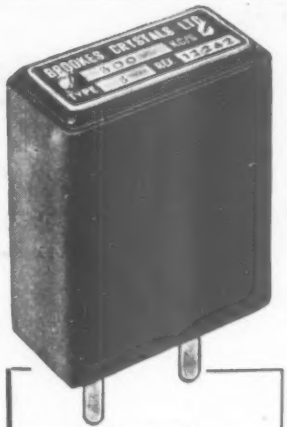

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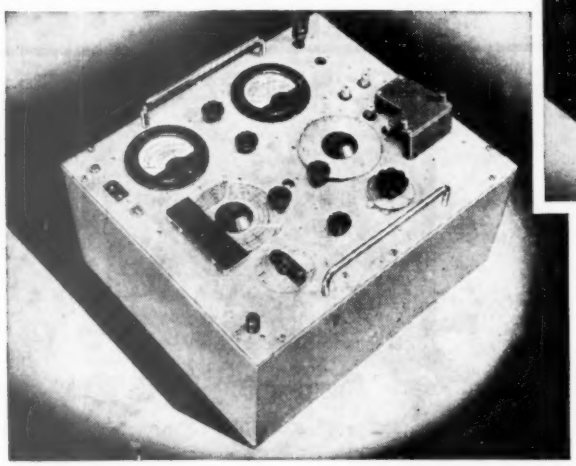

TF868

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Q: 0.1 to 10 (=10 to 0.1 tan δ)
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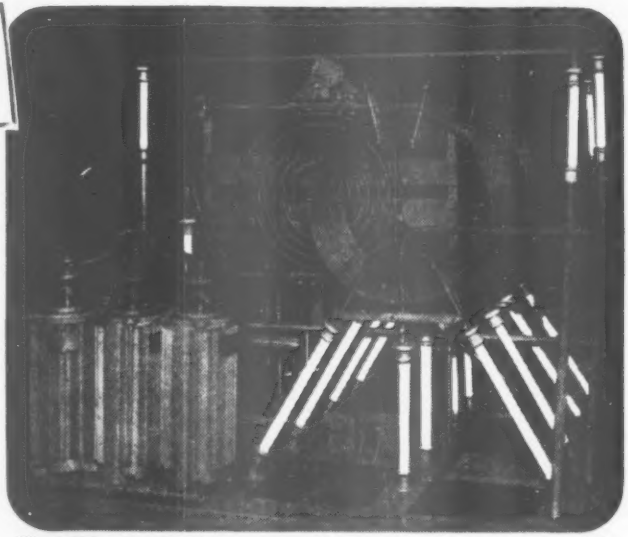

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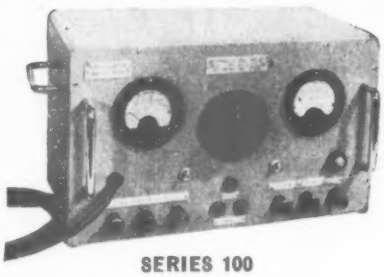

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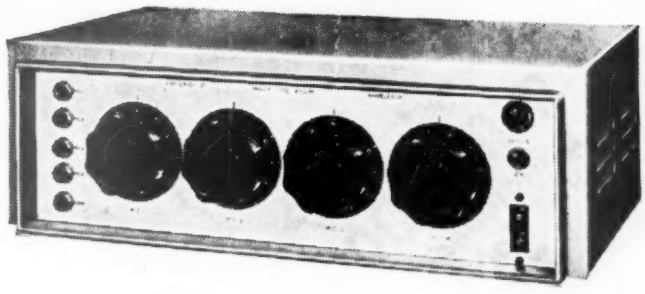

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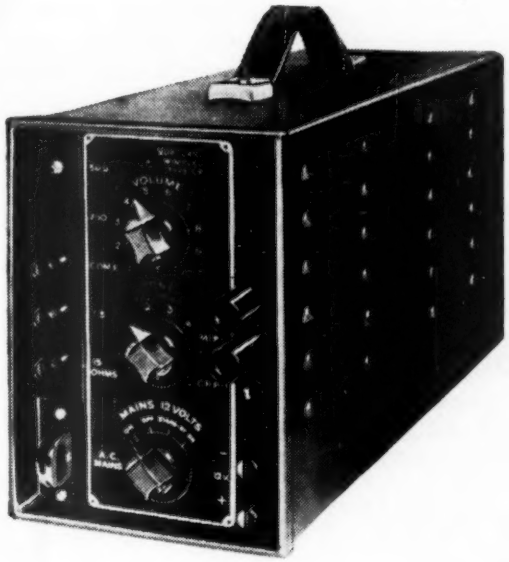

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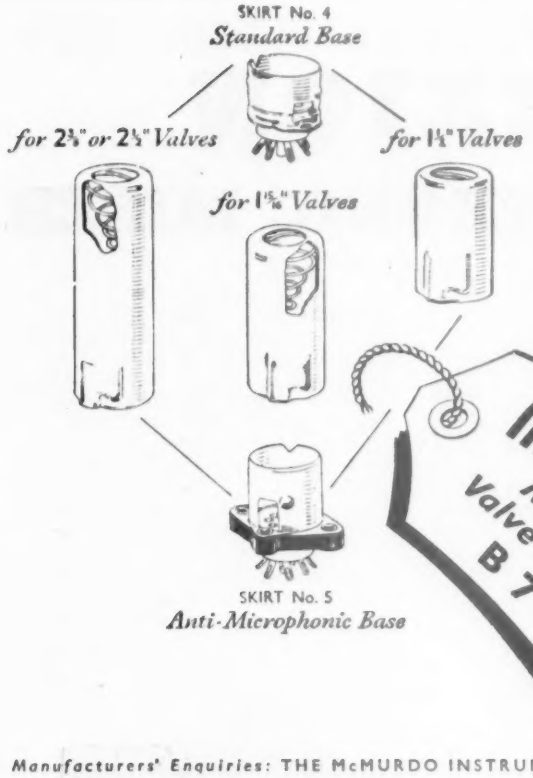

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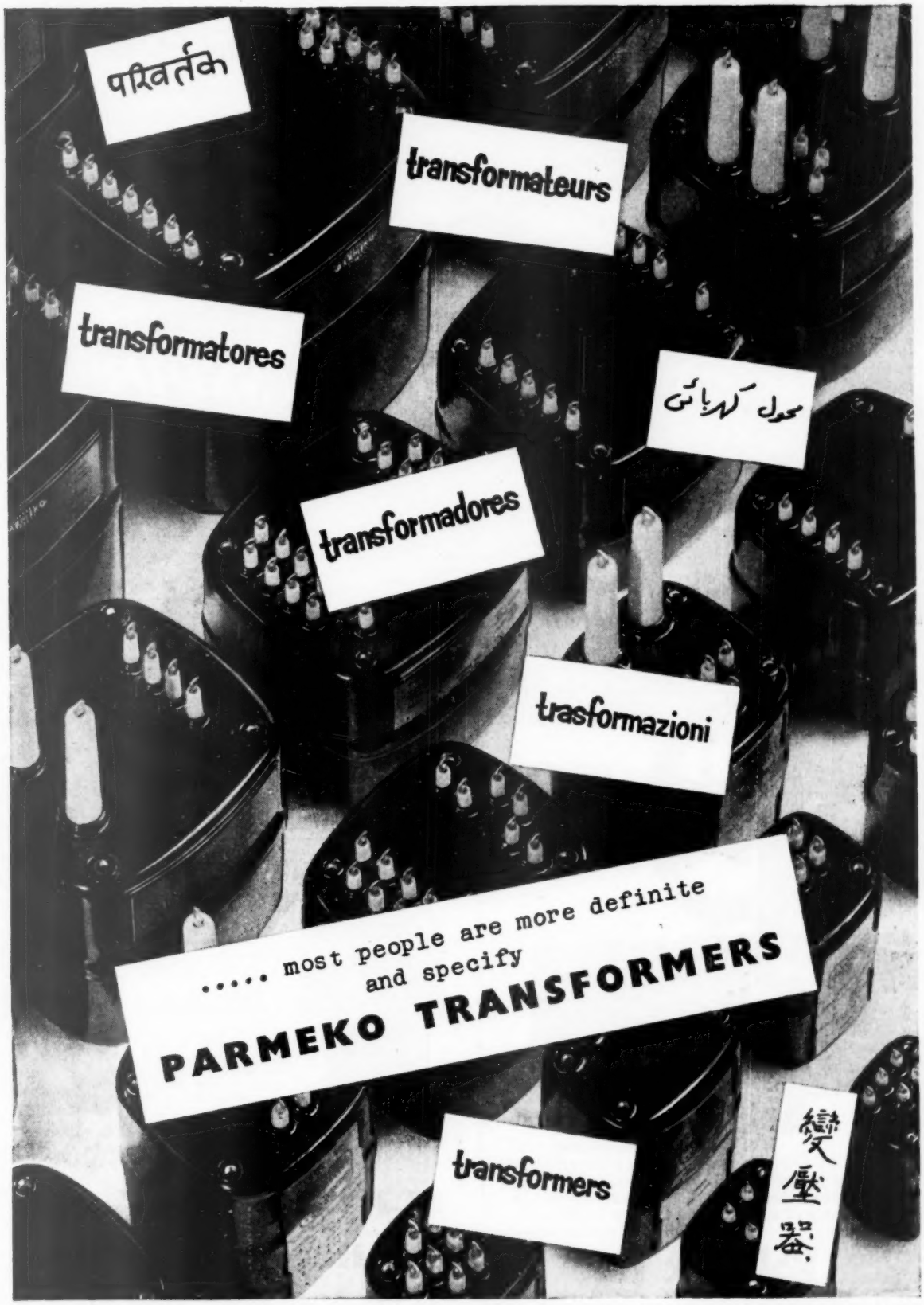

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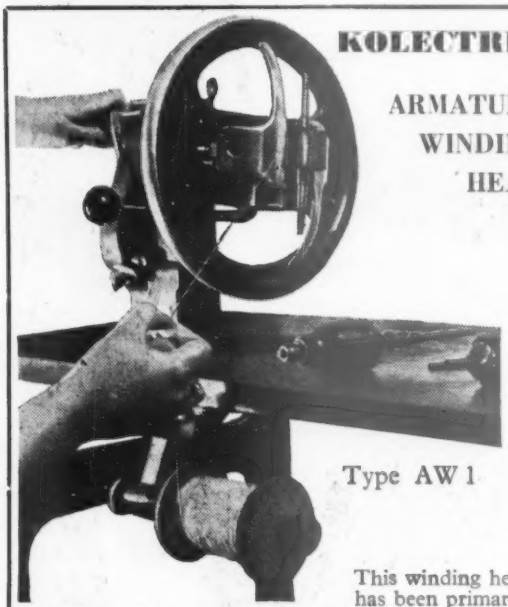

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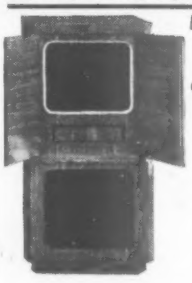

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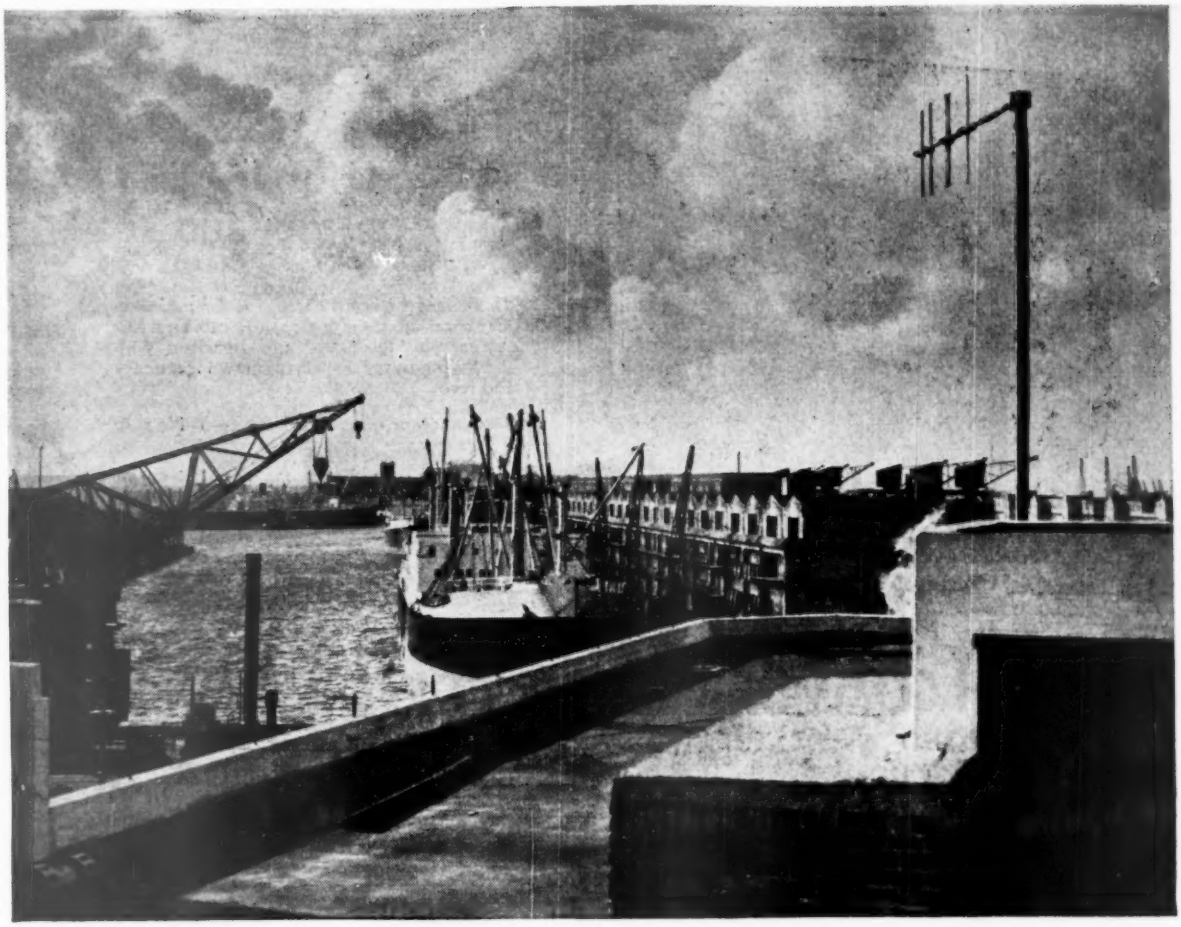

Aerial View

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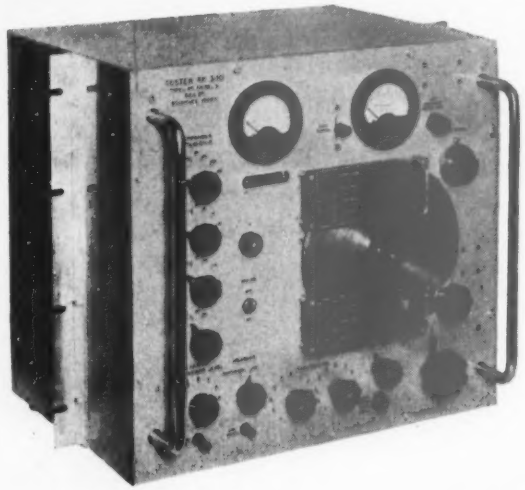

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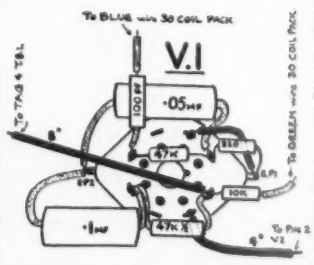

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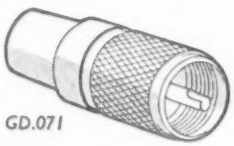
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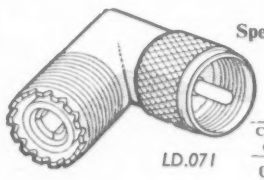
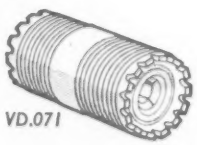
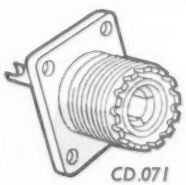
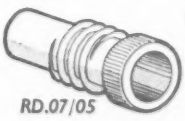

LD.071


VD.071


CD.071


RD.07/05

CABLE O.D.	TYPE	CODE NO.
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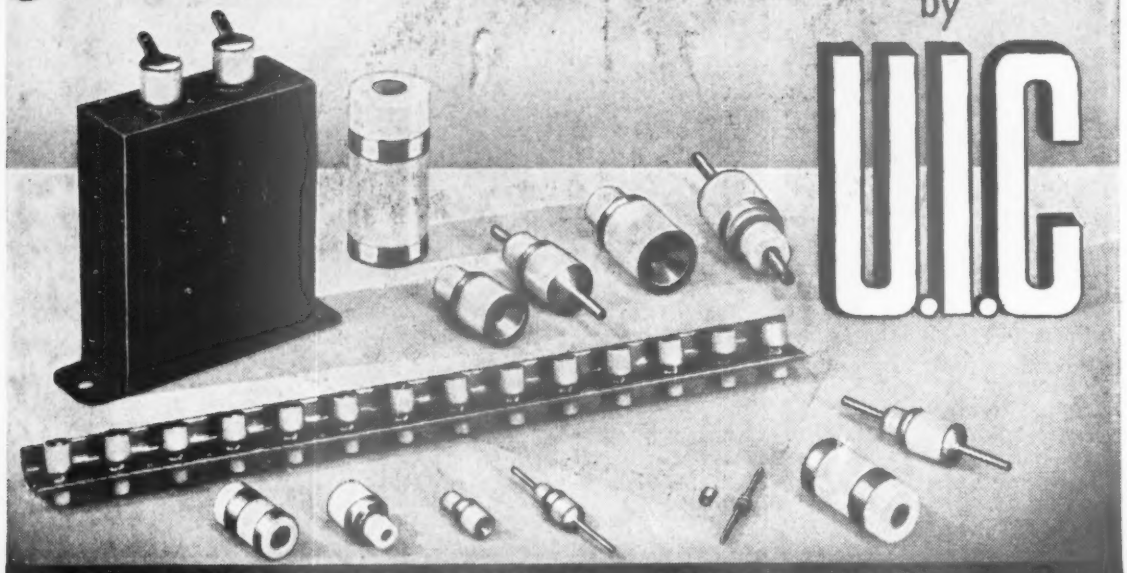

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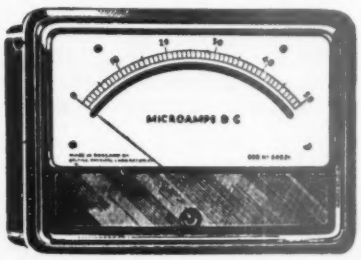

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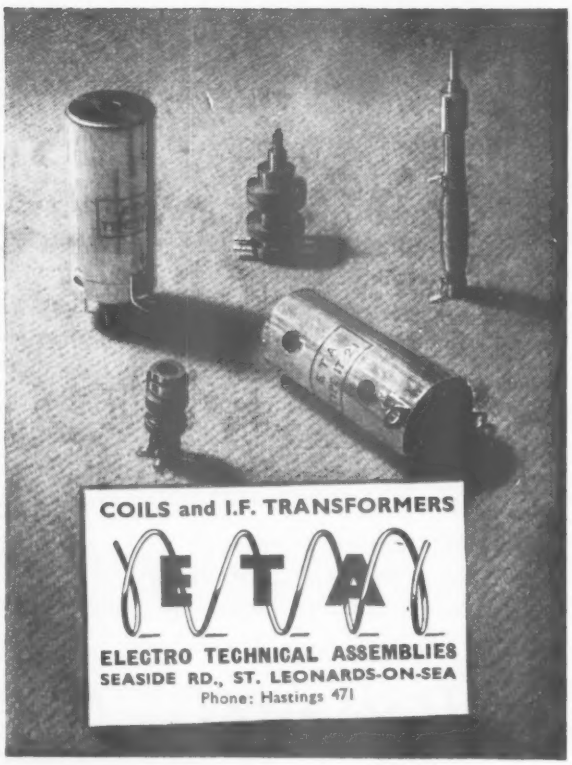

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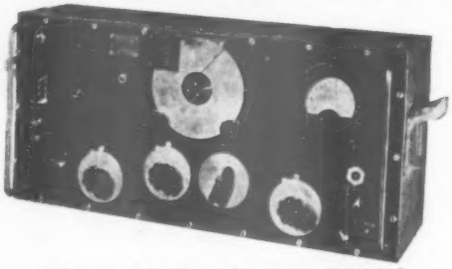

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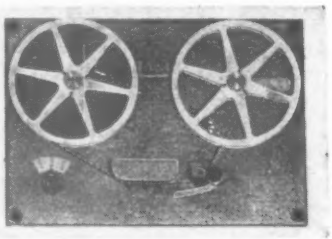

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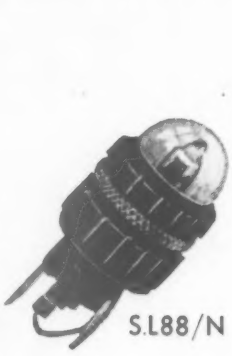
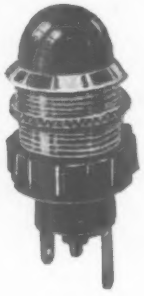

S.L.88/N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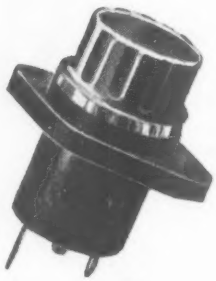
S.L.86.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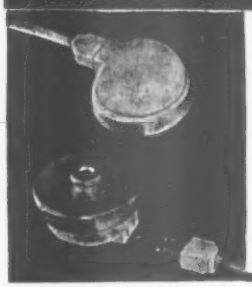

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For use on A.C. 200/250, 50 cycles mains only.

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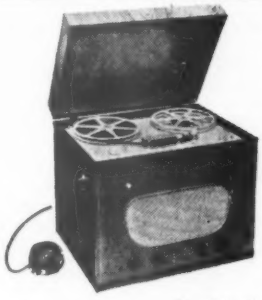
AMPLIFIER (already built, wired and tested)...	**£14.15.0** *plus* 7/6 *pkg./carr.*
LANE TAPE TABLE and REWIND SPOOL	**£16.10.0** *plus* 7/6 *pkg./carr.*
PORTABLE CABINET (rexine covered).....	**£4.19.6** *plus* 5/- *pkg./carr.*
MICROPHONE.....	**£2.19.6** *plus* 1/- *pkg./carr.*
REEL OF "SCOTCH BOY" TAPE (1,200ft.)	**£1.15.0** *plus* 6d. *pkg./carr*

As is usual in all PREMIER KITS every single item down to the last nut and bolt is supplied. The Chassis is punched and layout diagrams and theoretical circuits are included.

INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete kit of the Tape Recorder is ordered.

When completed the PREMIER PORTABLE TAPE RECORDER compares MORE than favourably with any other make at double the price.



PREMIER

TABLE MODEL MAGNETIC TAPE RECORDER

INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete Kit of the Tape Recorder is ordered.

IN KIT FORM—The Kit includes ALL parts, valves, cabinet, loudspeaker, Reel of "Scotch Boy" Tape, Rewind Spool and The NEW Lane Tape Table already assembled (*but excluding Microphone*).

SPECIFICATION AS PREVIOUSLY ADVERTISED

£29 : 8 : 0

(*Packing and Carriage* 15/-)

COMPLETE—to those unable to build this TAPE RECORDER, we offer it built, tested and ready to plug in, complete with "RONETTE" Microphone. Reel of "Scotch Boy" Tape and Rewind Spool.

SPECIFICATION AS PREVIOUSLY ADVERTISED

£36 : 10 : 0

(*Packing, Carr & Ins.* 1 *Gn.*)

★ *All the above Recorders are Fully Covered by the usual Premier Guarantee—3 months valves—12 months other components.*

The NEW Microphone . . . for TAPE RECORDING • AMATEUR RADIO • PUBLIC ADDRESS

A CRYSTAL MICROPHONE made specially for Premier by one of the world's leading manufacturers of Microphones. Although giving better all-round performance than most Microphones, we are able to offer this Unit at less than half the price of any comparable Microphone of other makes.

Brief Specification:—

SENSITIVITY—minus 55 d.b. relative to 1 v./-dyne/-cm².

RESPONSE—essentially flat from 30-10,000 c.p.s., recommended load resistance 5 megohms for flat response at low frequencies (2 megohms for slightly reduced bass response).

DIMENSIONS—overall length 5¼in. Width 2¼in. at widest part of Ball Top, tapering to ¾in. at base of housing.

The Microphone is unaffected by mechanical vibrations and low frequency wind noises. An attractive black all-metal housing provides complete screening and protection for the crystal insert. The crystal is virtually unbreakable and specially treated to minimise the effect of humidity. The modern design of the Unit enables it to be used as a Hand Microphone, with a Base as a Desk Microphone, or fixed to a Pedestal Floor Stand. Screw fitting for any standard British type Stand.

PRICE

£2 : 19 : 6

Especially recommended for use with the PREMIER MAGNETIC TAPE RECORDER

ALSO AVAILABLE FROM STOCK:

LUSTRAPHONE *Moving Coil: High Impedance* Stand type: **£5/12/6.** — Hand Mike: **£6/6/-.**

RONETTE *Crystal Microphone: Incorporating the Filter Cell Insert. High Impedance* Ball type: **£3/19/6.**

Table Stands for all the above 17/6.

OPEN TILL 6 P.M. SATURDAYS — TELEPHONES: AMBASSADOR 4033 & PADDINGTON 3271/2

PREMIER RADIO Company

(1933) S. H. MORRIS & CO. (RADIO), LTD. EST. 20 YRS.

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

Terms of Business: Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/-, unless otherwise stated.

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTs are centre tapped.

SP175B, 175-0-175, 50 mA., 4 v. @ 1 a., 4 v. @ 2-3 a. 25/-
SP250B, 250-0-250, 60 mA., 4 v. @ 1-2 a. 4 v. @ 3-5 a. 25/-
SP300A, 300-0-300, 60 mA., 6.3 v. @ 2.3 a., 5 v. @ 2 a. 25/-
SP300B, 300-0-300, 60 mA., 4 v. @ 2-3 a. 4 v. @ 3-5 a. 4 v. @ 1-2 a. 25/-
SP301A, 300-0-300, 120 mA., 5 v. @ 2-3 a. 6.3 v. @ 3-4 a. 28/-
SP301B, 300-0-300, 120 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 3-5 a. 28/-
SP350A, 250-0-350, 100 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a. 29/-
SP350B, 350-0-350, 100 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 3.5 a. 29/-
SP351, 350-0-350, 150 mA., 4 v. @ 1-2 a. 4 v. @ 2-3 a. 4 v. @ 3-6 a. 36/-
SP375A, 375-0-375, 250 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2.3 a. 39/6
SP375B, 375-0-375, 250 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 3-6 a. 39/6
SP501, 500-0-500, 150 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 2-2 a. 4 v. @ 3-5 a. 47/-
SP501A, 500-0-500, 150 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a. 6.3 v. @ 2-3 a. 50/-
SP425A, 425-0-425, 200 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2-5 a. 67/6

PREMIER VARIABLE IMPEDANCE "MATCHMAKER" MO.15 OUTPUT TRANSFORMER

Designed to meet the demand for an efficient variable ratio Output Transformer. 11 ratios from 13:1 to 80:1 all centre-tapped and can be used to match any output valves either single- or push-pull. Class "A," "AB1," "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 60 henries 15 watts audio 100 mA. Price 45/-.

WILLIAMSON AMPLIFIER KIT

A complete kit of parts for the construction of the latest version of this famous amplifier, complete with valves, output and mains transformers.

15 Gns.

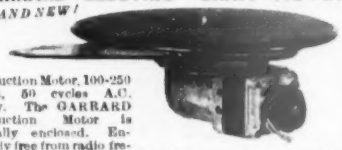
Plus 7/6 pkg., carr. and ins.

WILLIAMSON AMPLIFIER TRANSFORMERS (To specification)

The Output Transformer 3.6 ohms sec., £4/4/-.
The Mains Transformer **PREMIER SP425A**, £3/7/6.

GARRARD ELECTRIC 'GRAM MOTOR

BRAND NEW!



Induction Motor, 100-250 volt, 50 cycles A.C. only. The GARRARD Induction Motor is totally enclosed. Entirely free from radio frequency disturbance, magnetic hum and electrostatic. Variable speeds. With 12in. Turntable. Price £4/19/6, plus packing and carriage 5/-.

WEYMOUTH MINIATURE I.F. TRANSFORMERS

465 Kc/s, iron cored, permeability tuned, 10/6 pair.

WEYMOUTH MINIATURE COIL PACK

Covering Med./Long/Short wave bands. Iron cored coils. Dimens.: Height 1¾in. Length 3¼in. Width 2¼in. Spindle length 2¼in. *Complete with Circuit.* Price 19/6

MINIATURE TUNING CONDENSERS

2 gang .0005 mfd. with trimmers 6/9

H.T. ELIMINATOR Ex-Govt.

By famous manufacturer

NEW & UNUSED Input 200/250 v. A.C. Output, 120—at 30 mA. housed in strong metal box size 10in. long 7in. wide, 9¼in. deep.

37/6

Plus 2/6 pkg. and carr.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT

All parts to construct an eliminator to give an output of 120 volts at 20 mA, and 2 volts to charge an accumulator. Uses metal rectifier, £2.

MAINS NOISE ELIMINATOR KIT

Two specially designed chokes with three smoothing condensers with circuit diagrams. Cuts out all mains noise. Can be assembled inside existing receiver, 6/- complete.

SUPER QUALITY TELEVISION MAGNIFYING LENS

To suit 5in., 6in. or 7in. Tubes. Increase picture size considerably, 25/- each.

Famous Set Manufacturer's surplus of

ELECTRIC 'GRAM UNITS

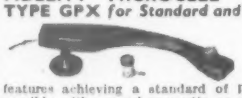
Two-speed, 33⅓ and 78 r.p.m. For playing Standard and L.P. recordings. Complete with Turntable. For use on 200-250 v. A.C. mains. Each unit is in its original manufacturer's carton and is fully guaranteed. Limited quantity only available at approx. half list price.

£3 . 19 . 6

Plus 2/6 pkg., carr. ins.

SPECIAL OFFER

THE FAMOUS "CHANCERY" HIGH FIDELITY MICROCELL PICK-UP — TYPE GPX for Standard and Long Playing



The Chancery Light Weight GP.X Pick-up embodies certain unique features achieving a standard of Performance not possible with normal magnetic or crystal pick-ups. The secret of the high standard of performance is in the use of the special microcell crystal cartridge assembly which has an unusually wide frequency response. The sapphire stylus is precision ground and semi-permanent. With two cartridges 1 L.P. and 1 Standard. **Price 52/6.** *Additional L.P. or Standard Cartridges can be supplied from stock at* **£1/11/6** *each.*

PORTABLE GRAMOPHONE CABINETS

A fortunate purchase of a manufacturer's surplus stock enables us to offer this first grade Portable Cabinet made by a famous manufacturer at the ridiculously low price of **39/6**

Plus 2/6 P. & P.

Specification: Substantial Wooden Case, Rexine covered, including wooden motor board, already cut to take a Gramophone unit. Almost any make of Rim-Drive Unit can be accommodated with ease. Outside dimensions: Height (when closed) 6in., Length: 15½in., Depth 13in. Inside dimensions: Length 14½in., Depth 12in. Clearance space under motor board: 2¾in. Clearance space from motor board to inside lid when closed 2¾in. These Cabinets are slightly warehouse soiled, i.e., the nickel plated fittings being a little rusted and the rexine requires polishing.

As a special offer for a limited period only the above Gramophone Unit, Pick-up and Cabinet, which will assemble into a complete Portable Electric Gramophone ready to plug-in to your Radio or Amplifier, can be supplied at **£8 · 5 · 0**

Plus 5/- Pkg., Carr. & Ins.

GRAMOPHONE UNITS

GARRARD TYPE 70. Autochange unit complete with Garrard magnetic pick-up head 78 r.p.m. ..... £8 . 8 . 0
GARRARD Rim Drive 78 r.p.m., complete with magnetic pick-up and turntable ..... £5 . 19 . 6
COLLARO 3-speed single gram. unit, complete with head for L.P. and Standard recordings ..... £8 . 8 . 0
COLLARO RC500 Autochange unit, 78 r.p.m. £8 . 8 . 0
All the above are for use on 200/250 v. A.C. mains.
Packing and carriage on each of the above units 5/-

THE NEW BSR "MONARCH" AUTO-CHANGER

This is a 3-speed automatic mixed record changer designed to play 12in., 10in. and 7in. records intermixed in any order. Capacity 10 records, operates on 100/125—200/250 volts 50 c/s. A.C.
New reversible dual stylus crystal pick-up has extended frequency range to 10,000 c.p.s. Self compensated for the L.P. lower frequencies with the Turnover frequency at the correct point. **PRICE £17/17/-**, plus 5/- packing, carriage and insurance.

AVAILABLE ONCE AGAIN! A.C.R. I.C.R. TUBES

5¼in. screen. 4 volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television, 15/- plus 2/6 Pkg., Carr. and Ins. *Data sheet supplied.*

V.C.R. 97 C.R. TUBES

We are once again able to offer this famous tube with the usual PREMIER guarantee of a full screen picture free from cut-off. Every tube is television picture tested before despatch. £2/5/-, post paid.

WHITE RUBBER MASK for 6in. tube 8/6

METERS

Large stocks available, a few of which are enumerated below:—

Full Scale Deflection	Scale Length in.	External Dimensions in.	Movement	
.5 A	1½	2½×2½	R.F. Thermo	7/6
2 A	1½	2½×2½	M/C	8/6
.25 A	1½	2½ round	R.F. Thermo	7/6
3 A	1½	2½ round	R.F. Thermo	7/6
3.5 A	1½	2½×2½	R.F. Thermo	7/6
4 A	1½	2½×2½	R.F. Thermo	7/6
8 A	1½	2½×2½	M/C	12/6
20 A	1½	2½ round	M/C	8/6
30 A	1½	2½×2½	M/C	8/6
40 A	1½	2½ round	M/C	8/6
1.5 mA	1½	2½ round		12/6
5 mA	1½	2½×2½	M/C	8/6
6 mA	2	3½ round		16/9
50 mA	1½	2½×2½	M/C	8/6
100 mA	1½	2½×2½	M/C	8/6
500 Micro/a.	1½	2½ round	M/C	15/-
20 V	2	3½ round	M/C	8/6
40 V	1½	2½×2½	M/C	8/6
1 mA	2	3½ round	M/C	25/-

1 mA METER IN PLASTIC CASE

The movement is 1 mA mounted in a case 3½in. square and 3¼in. high. The scale is 2½in. long and the dial is 2¼in. diameter. There is ample room in the case for a switch and multipliers. Internal Resistance 100 ohms **Price 27/6**

MOVING COIL METER

A super quality Moving Coil Meter basic movement 2 mA. Scale dimension 2¼in. Overall dimensions 2¾in. dia. 1¼in. deep. Bakelite Case projecting type. At present scaled 1 amp. R.F. By removing thermo couple, reversing scale and recalibrating the meter, a high grade test instrument with any range above the basic F.S.D. may be built up. **Price 4/9.**

RECTIFIERS

E.H.T. Pencil Type S.T.C.

Type K3/25	650 v.	1 mA.		4/7
,, K3/40	3.2 kV.	1 mA.		6/-
,, K3/45	3.6 kV.	1 mA.		8/2
,, K3/50	4 kV.	1 mA.		8/8
,, K3/100	8 kV.	1 mA.		14/8
,, K3/160	12 kV.	1 mA.		21/6

H.T. Type S.T.C.

Type RM1	125 v.	60 mA.	4/6
,, RM2	125 v.	100 mA.	5/-
,, RM3	125 v.	125 mA.	6/-
,, RM4	250 v.	250 mA.	18/-

L.T. Type. G.E.C. Full Wave.

6 v. 1 amp.	4/-
12 v. 1 amp.	8/-

MAGNETIC RECORDING HEADS

at approx. 25 per cent. less than list price. By a famous manufacturer. Low impedance, twin track. Frequency range 50-10,000 c.p.s. @ Tape speed of 7½in. per sec. Complete with circuit diagram of suggested associated components. Two types available: Record/Playback or Erase. Price 32/6 each.

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium, with four sides.

7×5¼×2in.	4/-
7×3½×2in.	3/9
9¼×4½×2in.	4/3
10×8×2¼in.	5/6
12×9×2½in.	7/-
14×9×2½in.	7/6
10×9×3in.	7/-
12×10×3in.	7/9
14×10×3in.	7/11
16×10×3in.	8/3
16×8×2½in.	8/-

ALUMINIUM PANELS 18 s.w.g.

7×6in.	1/3	7×4in.	1/-
9¼×6in.	1/8	9¼×4in.	1/5
10×9in.	2/2	10×7in.	1/11
12×9in.	2/8	12×7in.	2/5
14×9in.	3/2	14×7in.	2/11
16×9in.	3/8	16×7in.	3/5
20×9in.	4/8	20×7in.	4/5
22×9in.	5/2	22×7in.	4/11

ACCUMULATORS

By world-famous maker. 2 volt 10 amp. 4/11

CORRECT ASPECT WHITE RUBBER MASK

For 12in. Round or Flat-faced Tube 16/11

SORBO RUBBER MASKS

Grey Felt finish (new aspect ratio). 9in., 5/-; 12in. 9/6

OPEN TILL 6 P.M. SATURDAYS

TELEPHONES: AMBASSADOR 4033 & PADDINGTON 3271/2

PREMIER RADIO Company

(REGD.) B.H. MORRIS & CO. (RADIO), LTD. EST. 40 YRS.

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

Terms of Business: Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/- unless otherwise stated.

CAR BATTERIES—*BRAND NEW*

6 v. 11 plate—**PREMIER.** Height, 6¼in.; Length, 7¼in.; Depth, 6¼in. Price **65/-**.
6 v. 11 plate—**PREMIER.** Height 8¼in.; Length, 6¼in.; Depth, 6¼in. Price **65/-**.
12 v. 9 plate—**PREMIER.** Height, 8¼in.; Length, 12in.; Depth, 6¼in Price **110/-**.
6 v. 15 plate—**THOR.** Height, 7¼in., Length, 6in.; Depth, 7in. Price **75/-**.
6 v. 40 amp.—**PREMIER.** Parking Light Battery. Price **37/6**.
6 v. 18 amp.—**PREMIER.** Parking Light Battery. Price **27/6**.

All prices plus 7/6 carr. and packing.

BATTERY CHARGERS

200-250 v. A.C. Will charge 6 v. or 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size: 6in. long, 3¼in. wide, 3¼in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain ex-Govt. components. Plus 2/6 Post and Pkg. **39/6**

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. cycle mains.

Cat. No.
2002 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator ..... **£1 . 2 . 6**
2003 Charges 12 volt accumulator at 1 amp. **£1 . 7 . 6**

CHARGER TRANSFORMERS

Input 230 v. A.C. Output 12 v. @ 1 amp. Completely shrouded. Price **9/11**.

Govt. Surplus—Ex W.D. STEEL AERIALS *ALL BRAND NEW*

12ft.—3 4ft. sections of copper-plated steel highly flexible tapering ¼in. to ⅛in. Brand new in container, **6/9**. Packing and carriage 1/6. Insulated Base, **3/-**. Webbing waterproof carrying case with shoulderstrap, **2/6**.

These aerials make ideal fishing rods.

EX-U.S.A. U.H.F. AERIAL

with untuned detector stage, consisting of V.R.92 valve etc. Brand new, in carton, **5/-**.

2 STAGE QUALITY AMPLIFIER

Complete with 10 in. Energised LOUDSPEAKER

4 watts output. A.C. 110/230 mains.

£6 . 19 . 6

plus 5/- carriage.

FRACTIONAL H.P. MOTOR

A 50 v. 3-phase A.C. motor, 1/40th h.h.p. by famous maker. Supplied complete with resistor, condenser and circuit diagram to convert the motor to ¼ h.p. for use on 240 v. single phase A.C. mains. Brand new, **25/-**, plus 2/6 carriage and packing.

MAGNETIC MARCHING COMPASS

Luminous Dial, enclosed in black bakelite case. Size: 3in. × 2¼in. × 7¼in.

Price **18/6**.

HEADPHONES

Balanced Armature Low Resistance

Type 1, **6/11** pair; Type 2, **8/11** pair.

High Resistance (S. G. Brown), 4,000 ohms, **10/9** pair.

Standard Type 12/6 pair

Lightweight High Resistance 14/6 pair.

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The Ideal Mike for tape, wire and recording and sound projectors. Price **22/6**.

MOVING COIL MICROPHONE

Low impedance. Incorporates press-to talk switch. Housed in strong black bakelite case. Dimensions: 2in. wide, 2¼in. high, 1¼in. deep.

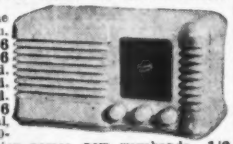
Plus 1/6 post and packing **19/6**

A matching transformer for high impedance can be supplied at **3/6** extra.

MICROPHONE STAND BASE

Heavy Moulded Black Base fitted with Standard thread adaptor. Dimensions: 7¼in. across, 2in. deep. Weight: 1¼lb. post paid, **3/11**.

BUILD A PROFESSIONAL LOOKING RADIO SET AT LESS THAN HALF TO-DAY'S PRICE



We can supply all the parts to help you.

Drum (2¼in. dia.),	1/6
Driving head,	1/6
Double pointer	4d.
Spring	3d.
Nylon Cord (yard)	6d.
Dial Front Plate	2/6
Engraved Glass Dial. 180-550 and 800-2,200 m.	1/6
With station names, new wavebands	1/6
T.R.F. Coils, 180-550, 800-2,200 metres, pair	6/6
Punched chassis, 3-valve plus rectifier T.R.F.	3/9
Cabinet, Bakelite, in Walnut or Ivory or Wooden in Walnut finish	17/6
Packing and Insurance	2/6

SEND 1/6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver Illustrated above.

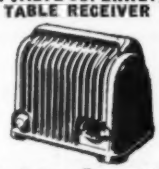
THE COMPLETE KIT

to construct a 3-valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at **£6/9/6**, plus 2/6 packing and carriage.

Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated, and the Receiver housed in its Cabinet size 12in. × 5in. × 6in. presents an attractive appearance. The valve-line-up is: 717A—H.F. Pentode, VR116—Detector, APT4—Output, and Metal Rectifier.

Waveband coverage is for the medium and long bands. Choice of 3 Cabinets: Bakelite in Walnut or Ivory, or Wooden (Walnut finish).

ONLY A FEW LEFT—BUY NOW! THE FAMOUS 'SOBELL' 4 VALVE SUPERHET TABLE RECEIVER



M. & L. WAVEBANDS

Valve Line-up 12J7, 35L6, 1487, 35Z4.

Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.

Choice of 2 Colours—Ice Blue or Aero Green.

Carrying handle incorporated in design. For use on 200/250 A.C./D.C. mains. **£8 . 19 . 6**

Plus 5/- Pkg./carr./Ins.

Covered fully by Manufacturer's Guarantee

LOUDSPEAKERS

Still available—TAX FREE!

ELAC—2½in. dia., Moving Coil, 15 ohms imped.	15/-
PLESSEY—3in. dia., Moving Coil, 3 ohms imped.	15/-
ELAC—3½in. dia., Moving Coil, 3 ohms imped.	15/-
ELAC—5in. dia., Moving Coil, 3 ohms imped.	14/6
ROLA—6½in. dia., Mains Energised, 3 ohms imped. (1,140 ohms field), with transformer.	15/-
PLESSEY—8in. dia., Moving Coil, 3 ohms imped.	14/6
PLESSEY—8in. dia., Mains Energised, 3 ohms imped. (600 ohms field), with Pentode Transformer	22/6
PLESSEY—8in. dia. Mains Energised, 3 ohms imped. (600 ohms field)	19/6
PLESSEY—10in. dia., Moving Coil, 3 ohms imped.	23/6
GOODMANS—12in. dia., Moving Coil, 15 ohms. Plus 5/- packing and carriage.	£8/8/-
VITAVOX—K12/20 12 in. dia., Moving Coil, 15 ohms imped. Plus 5/- packing and carriage.	£11/11/-

6L INDICATOR UNITS

Complete with VCR97, 4—VR91, 3—VR54, **£3/15/-** Plus Pkg. and Carr. 7/6.

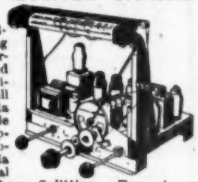
POWER SUPPLY UNIT No. 7

Ref. ZA17571. A complete Unit for charging 6-volt Accumulators, by hand. Designed for the W-S21 could be used for many other purposes. Consists of a stout metal case, dim. 17×10½×7½in., with detachable lid, containing hand driven generator, with gear mechanism which delivers 6 volts D.C. at 4 amps., also 6 volt cut out and battery clamp. Price **32/6**, plus 5/- post/pkg.

ROTARY CONVERTER POWER SUPPLY UNITS.

12 v. D.C. Input, 230 v. 30 mA Output. Completely smoothed. Complete with case, **19/6**. Plus Pkg. and Carr. 5/-.

A WORLD-FAMOUS Manufacturer's Surplus of RADIO RECEIVER CHASSIS 7-valve RECEIVER



Built to exacting specifications and incorporating features ensuring superlative tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 45 valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 Kc/s., using Mazda VP41. **FOUR WAVEBANDS**—**14 M.-34 M., 24 M.-55 M., 190 M.-800 M., 900 M.-2,000 M.**

DIRECT AND VERNIER TUNING. Gram. position on Switch. Provision for external Loudspeaker. For use on 200/250 A.C. Mains. **£13/10/-**, plus 21/- pkg. and carr.

1124 RECEIVER UNIT

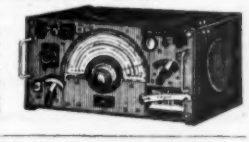
Range 30 to 40 Mc/s. Contains six new Valves. 3-9D2, 1-8D2, 1-15D2 (frequency changer), 1-4D1, 24 ceramic trimmers, 6 ceramic valve-holders, 6 valve screening cans, 30 resistors, 1-W/W Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former, 2 Westector WX6 and 1 Westector WX4, 5-way 4-bank switch with long spindle, I.F. transformers, etc.

Brand new in maker's carton at **17/6**, plus 3/6 postage and packing.

R1132A RECEIVER. Complete with valves **£3/19/6**. *Plus pkg. & carr.* 10/6.

1155 RECEIVER UNIT

BRAND NEW



In original cases, complete with 10 valves. Frequency range 18.5 Mc/s-75 Kc/s. in 5 wave bands. **£11/19/6**. 10/6 packing and carriage.

POWER SUPPLY UNIT

for above incorporating output stage. Supplies an output of 250 volts at 80 mA., which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6½in. speaker is built into the unit. **Price £5/5/-**, plus 5/- packing and carriage.

As a special offer, power supply unit including speaker together with R1155 receiver. PRICE £16.19.6, Plus 15/- pkg. & carr.

★ *We now have available a small quantity of used R1155 Receivers. We can offer these at the ridiculously low price of £9/19/6, plus 10/- pkg., Carr., Ins. These Receivers have been reconditioned and Air Tested and are fully guaranteed to be in perfect working order.*

R1355 RECEIVER AMPLIFIER

with 5 I.F. Stages for T.V. conversion. Contains 7 VR65's, 1—6U4, 1—VU120, 1—EA50, **£1/19/6**. Plus, pkg. and carriage 10/-.

RF 25 UNITS

Frequency covered 40-50 Mc/s (6-7.5 metres) switched tuning. 5 Pre-set positions complete with 3 VR65's. **£1/5/-**. Plus, pkg. and carr., 2/6.

RF 26 UNITS

The ideal short-wave converter for T.V., variable tuning, contains 2—EF54, 1—VR137, **£2/19/6**. Plus pkg. and carr. 2/6.

**As a special offer we can supply the R1355 complete with RF.24 or RF.25 at 59/6, or with RF.26 at £4.17.0, plus carr.*

R3136 RADAR RECEIVER UNIT

Containing 19 valves, 6—VR65, 2—6J7G, 2—VR116, 3—6Q7G, 1—VR54, 1—VR137, 2—VR136, 1—VR92, 1—5Z4G, the Unit incorporates an R.F. strip followed by an IF strip, **£5/7/6**. Plus, pkg. and carr., 10/-.

SPECIAL OFFER DOUBLE WOUND AUTO-TRANSFORMER 250 watts.

Input/Output	Output/Input	
100 volts	110 volts	
110 ,,	113 ,,	
200 ,,	116 ,,	
210 ,,	119 ,,	Price **42/6**
220 ,,	122 ,,	Plus 2/6 Pkg. Carr.
230 ,,	134 ,,	
240 ,,	146 ,,	
250 ,,		

With the two windings connected in series a vast number of voltage tappings are available.

CITY SALE & EXCHANGE

THE HIGH FIDELITY SPECIALISTS **LIMITED**

90-94, Fleet Street, London, E.C.4. **Phone: Central 9391/2**

Offer the following from their extensive stocks:

SPEAKERS

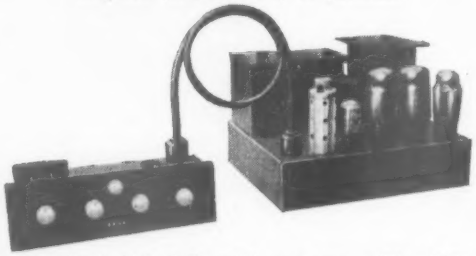
Decca corner horn **£30/16/4**; **Richard Allan** Prestige speaker, **£22/14/-**; **Lowther,** P.W.1 corner horn, cabinet only **£32/10/-**; **Salex** 12in. walnut veneered reflex cabinet, **£9/15/-**; **Ditto,** 10in., **£9/5/-**; **Wharfdale** W15/CS speaker unit, **£16**; W12/CS **£14/1/5**; Golden 10in., **£8/6/-**; Super 8 C/S AL **£7/4/4**; **Goodmans** Axiom 150 Mark II, **£14/13/4**; Axiom 101 high flux 8in. unit, **£7/2/9**; Axiom 102, **£10/14/2.**

TUNERS

Leak Vari-selectivity **£38/5/-**; **Acoustical** Q.U.A.D. 4 station pre-set, **£27**; **Lowther** DT4 7 valve straight/superhet, magic eye, **£37/17/10**; **Lowther** L.E.S. 6 valve 3 wave, high fidelity, **£25/15/4.**

AMPLIFIERS

LEAK TL/12 Point one with Vari-slope pre-amplifier (as illustrated) **39 guineas.**



Acoustical Q.U.A.D. with pre-amp. **£35**; **R.D. Junior** 8 watt model **£28/10/-**; **R.D. Baby de Luxe,** 5 watt **£22/10/-**; **Polished walnut console cabinets** for above amplifiers, **£10/10/0 each.**

PART EXCHANGE—
OUR SPECIALITY

Let us take your existing equipment in part payment for the most up to date. Write giving details.

RECORD PLAYERS

Decca 75 3 speed auto., portable case with either XMS or crystal heads, **25 gns.**; **Decca** 3 speed in portable case, magnetic or crystal, **£19/19/-**; **Connoisseur,** 3 speed motor, fitted super lightweight P.U., 2 heads, **£33/13/8**; **Garrard** RC80 gram unit, 3 speed, auto **£22/10/-** complete with Decca XMS heads; **B.S.R.** Monarch auto unit, turnover crystal P.U., **£17/17/-**; **Garrard** 201B/5 variable speed transcription motor **£24/8/9.**

SECONDHAND EQUIPMENT

Acos GP.20 Pick Ups, **30/-** each, standard or Long Playing; **Garrard** RC65 and 70 auto-change units, **£6/6/-**; **Decca,** 33⅓ only record players, **£6/6/-**; RC72A Changers, **£10/10/-**; **Deccola,** 3 speed 8 waveband Radiogram, **£195**; **McMichael,** 7 valve 4 wave-band, 3 speed, auto, **59 gns.**; **Murphy,** 12in. Television console with doors, **65 gns.**

Hire Purchase terms can be arranged on all new equipment—one-third of the amount as deposit, and the balance over 12 months. Write for order forms.

THE FAMOUS **BENNETT COLLEGE**

can help your career through personal postal tuition

In any of these subjects:

Accountancy Exams ★ Aircraft Eng. & Radio ★ Architecture ★ Auditing ★ Book-keeping ★ Building ★ Carpentry ★ Chemistry ★ Civil Service ★ Commercial Art ★ Commercial Arithmetic ★ Company Law ★ Costing ★ Diesel Engines ★ Draughtsmanship ★ Electric Wiring ★ Engineering (Civil; Electrical; Mechanical; Motor; Steam; Structural) ★ Jigs, Tools and Fixtures ★ Journalism ★ Languages ★ Mathematics ★ Mining ★ Modern Business Methods ★ Plumbing ★ Police ★ Press Tool Work ★ Quantity Surveying ★ Radio ★ Salesmanship ★ Secretarial Exams. ★ Shorthand ★ Surveying ★ Telecommunications ★ Television ★ Textiles ★ Works Management ★ Workshop Practice

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SUCCESS WILL BE YOURS

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TO THE BENNETT COLLEGE (DEPT. C41) SHEFFIELD

Please send me your prospectus for.....
(Subject)

NAME .....

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PLEASE WRITE IN BLOCK LETTERS

HANNEY of BATH offers

STANDARD VIEWMASTER. Constructor's Envelope, **7/6**; complete kit with wire, sleeving, nuts and bolts, less valves, tube and cabinet, **GENUINE** parts only, **£31. OR** in 7 easy stages: 1, **62/3**; 2, **42/9**; (Wenvoe, **39/-**); 3, **£5/1/8**; 4, **9/10**; 5, **£10/4/-**; 6, **27/5/9**; 7, **67/8**; Individual Parts (any item separately), WB100 (sound and vision chassis), **18/6**; WB101, **6/-**; WB102, **19/6**; WB103, **42/-**; WB103A, **52/6**; WB104, **15/6**; WB105, **47/2**; WB106, **25/6**; WB107, **32/6**; WB108, **33/3**; WB109/1, 2 or 3 (state tube type), **22/6**; WB110, **10/-**; WB112, **21/6**; WB Console conversion kit, **35/-**; WB300 pre-amp. chassis, **17/6**; Westinghouse Rectifiers, 14A86, **20/4**; 14D36, **11/7**; WX3 and WX6, **3/9** each; 36EHT100, **29/5**; 36EHT50, **26/1**; 36EHT45, **23/8**; K3/100, **14/8**; K3/50, **8/9**; K3/45, **8/2**. T.C.C. Condensers, **£7/10/-** (any condenser supplied separately). Morganite pots., **5/-** each; Morganite resistors, **35/3**. Colvern pots, **22/6**; or CLR901, **3/3** each and CLR4089/22, **6/4**. Belling Lee L707, **8/9**. Fuses **6d.** each. Wearite Coilsets (with L9), L'don., **22/-**; Wenvoe, **28/-**; B'ham., R'Moss and K.-O.-S., **30/-**. Pre-amp coils, **4/-** pair, any channel. Special condensers are also available for the WIDE ANGLE Viewmaster.

TELEKING. Constructor's Envelope, **6/-**. Coilsets, **54/3**; Chassis Kits, **70/-**; T.C.C. Kit, **£7/4/3**; R.M.4 rectifier, **21/-**; Allen Wide Angle Components, LO.308, **50/-**; FO.305, **21/-**; DC.300, **42/-**; FC.302, **35/-**; GL.16 and GL.18, **10/-** each; BT.314, **15/-**; SC.312, **22/6**; AT.310, **30/-**; OP.117, **9/-**; Resistors and Pots. are detailed in our TK Supplement.

MAGNAVIEW. Constructor's Book from BRIMAR Valves. Denco coilsets, **41/2**; Chassis kit, **37/6**; Erie resistor kit, **39/2**; DENCO Wide Angle Components (also suitable for TK.) WA/DCA1, **43/-**; WA/FCA1, **31/-**; WA/LC1 and WA/WC1, **7/6** each; WA/FBT1, **16/-**. Condensers and pots. as per our Magnaview Supplement. ELAC Mark 2 PM Focus Rings (with Vernier Control), R.17, **28/6**; R.20, **30/-**; R.25, **32/6**; W.22 **52/6**; W.25, **57/6**. Ion Traps 1T6, 1T8 and 1T9, **5/-** each.

WILLIAMSON AMPLIFIER. All resistor and condenser kits still available as per our February advert.

SUNDRIES. LANE MK. 3 Tape-tables, **£17** (inc. carriage); Eddystone 740 Receivers, **£38/15/-** (old price); OSMOR Q Coilpacks, HO, **52/-**; LM, **43/4**; TBP, **43/4**; Q coils, **4/-**; QC1 HF Chokes, **4/-**; Weymouth H coils, **3/9**; Wearite P coils, **3/-**; Denco Maxi-Q coils, **3/11**; Denco "C" TRF coils, **8/-** pair; Astral TRF coils M. & L.W., **4/3** each. Polystyrene Varnish, **1/10**; 50 watt output trans. for 6L6, 6V6, KT66 or PX4 in push-pull, **47/3**; Valve Manuals by Mullard, Osram and Brimar, **5/6** each, post free. Filament trans. 6.3 v. 1.5 a., **7/6**; ACOS Mikes, Mic 30, **84/-**; Mic 22-1 or 2, **6 gns.**; Mic 16-1 or 2, **12 gns.** J.B. Drives, Gram-motors, Auto-changers and P.U.s still available as per February advert.

Send 6d. stamp for our List and Supplement, which covers all recent designs. Terms of Business C.W.O. or C.O.D. (over £1). Please add 9d. postage on orders under £2.

L. F. HANNEY

77 Lower Bristol Road, Bath. Tel. 3811.

Great Britain's Valve Mail-Order House

RADIO BULLS VALVES
246 HIGH ST. HARLESDEN NW10

JEWEL (SAPPHIRE mounted). Suits any type of Pick-up or Record. Improves quality, eliminates record wear. 3 Types: Loud, Soft and Trailer. 3 for 10/-, or 3/6 each

TAYLOR Montrose 7-range Multimeters, A.C./D.C.

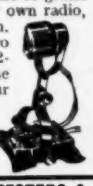
3 amp. precision M/I movement. 0-6-30-150-300 volt. 0-30 mA.—300 mA.

50/- Post free.

10th Anniversary Year

HOME BROADCASTER

Connects to radio or gram. Talk over your own radio, room to room. Easy to fix. Two mikes make 2-station house phone in your own home. Order to-day.



12/6 post 1/6.

Electric ENGRAVER

For all metals, plastics, etc. Plugs into A.C. light socket. Powerful.

15/- Post 1/-.

Q-MAX CHASSIS CUTTERS AND KEYS

⅛in. 12/4; ¾in. 12/4; ⅞in. 13/4; 1in., 1¼in. and 1½in., 16/- each; 1⅝in. and 1¾in. 18/- each; 1⅞in. 19/9; 2⅛ in. 31/9; 2½in. 36/9; 1in. square 24/3.

AMPLION TEST METER

1,800 ohm per volt on all D.C. and A.C. ranges, 10 v., 100 v., and 500 v. D.C. and A.C. 50 mA. and 500 mA. D.C. Resistance up to 200,000 ohm (3,000 ohm centre scale), with self contained battery. 5,000 volt range with a separate H.T. test prod (9/6 extra). Supplied with test prods. Multi-colour scale easily readable. Post free

£5

SERVICE SHEETS

The one you require enclosed if available in a dozen assorted of our best choice.

10/6

CONDENSER TESTERS & RECTIFIER UNITS

Plugs straight into A.C. mains, 200/240 v., and is indispensable for examination of condensers. Very slight and intermittent leakages which cannot be discovered by conventional instruments can be traced by this unit. Complete. Post 1/-. Supplies are becoming limited.

39/6

A.C./D.C. NEON TESTER, TYPE 400

This new model is specially designed for one-pole tests on mains, incorporating a highly sensitive neon tube—striking voltage 100/500 v. A.C./D.C. Also suitable for indicating polarity on D.C. current, when the glow of the lower electrode will indicate the negative pole. Post 6d.

11/3

EASY TERMS ON ALL TAYLOR METERS

Terms up to 10 months and very near Cash Price. Please ask for full List, Terms and Proposal Form.

All Purpose INSPECTION AND GARAGE HAND LAMP

With stout galvanised wire guard. Superior quality. (Less flex and bulb.)

Post 1/- 6/6

CV		CV		CV		CV		CV	
21	10/6	616	9/6	924	9/6	1073	7/6	1180	8/6	1945	14/6
26	112/-	619	9/6	931	12/-	1075	11/6	1191	11/6	1948	13/6
32	14/6	623	44/6	938	9/6	1078	4/6	1195	8/6	1951	14/6
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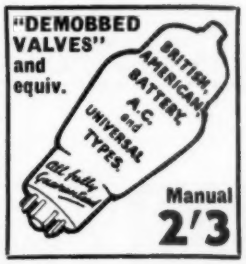
124	16/6	659	9/6	1023	6/-	1100	6/6	1300	7/6	1978	9/6
133	9/-	666	7/6	1027	5/6	1106	8/6	1306	9/6	1981	9/6
138	13/6	692	9/6	1035	11/6	1107	16/6	1308	12/6	1986	11/6
181	12/6	694	9/-			1108	9/6	1320	8/-	1988	12/6
216	14/6	697	9/6					1323	9/6	1993	8/-
330	8/6	700	8/9					1327	12/6	1999	11/-
500	9/6	703	11/6					1331	9/6	2500	11/6
504	9/6	706	9/6					1335	10/6	2506	8/6
511	11/-	711	8/6					1338	12/6	2514	14/6
522	10/6	729	9/6					1344	10/6	2531	10/6
523	9/6	730	11/6					1356	11/6	2543	10/6
525	8/6	731	10/6					1401	13/6	2544	14/6
529	11/6	747	8/6					1419	14/6	2556	17/-
531	10/6	756	9/6					1433	12/-	2557	17/-
534	8/-	758	10/6					1438	12/-	2558	11/6
538	10/6	773	6/6					1456	12/6	2570	5/6
543	10/-	781	6/1					1457	10/6	2809	14/6
545	11/6	782	13/6					1463	14/6	2875	13/6
548	5/6	783	12/-					1752	9/6	2909	11/-
552	10/6	784	12/-					1755	9/6	2911	9/6
554	8/-	785	11/6					1760	10/-	2912	12/6
555	11/6	786	10/6					1817	8/6	2938	12/6
556	10/6	815	8/-					1819	9/-	2941	7/-
561	10/6	822	14/-					1851	13/-	2985	13/-
571	11/6	845	9/-					1854	12/6	2996	12/6
573	10/-	848	10/-					1861	14/-	2999	11/6
575	13/-	851	8/6					1864	11/-	3502	10/6
583	8/6	856	9/6					1891	11-/	3527	10/3
585	9/6	858	16/-					1893	10/6	3546	14/6
588	12/6	862	8/6					1896	14/-	3601	6/6
594	8/-	873	10/-					1900	9/6	3647	6/3
596	11/6	877	9/6					1926	9/6	3702	7/6
606	9/-	885	12/6					1931	7/6	3751	12/-
608	19/6	887	11/6					1934	7/6	3781	11/6
609	11/6	895	10/-					1937	9/-	3798	9/6
613	10/-	901	10/-					1938	10/6	3799	8/6
614	17/-	916	6/6					1942	9/9	3830	6/-
615	9/6	922	8/6					1943	9/-	3888	12/6

"DEMOBBED VALVES" and equiv.



Manual 2/3

Plus 9d. Postage.

For further Types refer to Page 57 in January issue.

CONDENSERS

Wire Ends

2 mfd.	450 v.	2/-
4 ,,	450 v.	2/6
8 ,,	500 v.	2/6
16 ,,	500 v.	2/9
25 ,,	25 v.	1/3
50 ,,	50 v.	2/-

Cans

8×8 mfd.	500 v.	3/6
8×16 ,,	500 v.	4/9
16×16 ,,	500 v.	5/9
16×24 ,,	350 v.	5/9
16×32 ,,	275 v.	6/6
16 mfd.	175 v.	1/-

Post 6d.

Universal Minor, £10. Model 7 and 40 Avometers, £19. Electronic Testmeter, £40. AVO Model 8, £23/1/-.

DULCI CRYSTAL RECEIVERS

For reception of Medium and Long Wave bands. Scientifically designed for serious listening. The most efficient Crystal Receiver obtainable. Employing supersensitive Germanium Crystal Diodes. High Fidelity Reception.

49/6

PIFCO, all-in-one Radiometer

A.C./D.C., tests everything in Radio, Complete with Test prods. Limited Supply

Post 6d. 29/6

MICROPHONES	
RESLO RV Ribbon	£9 0
,, VB Ribbon	£7 5
,, PGD	£9 0
,, VMC	£6 0
ACOS 30	£4 4
,, 22/2	£6 6
,, 16/2	£12 12
GRAMPIAN MCR/M C. DP2 W/8	£5 17 £6 10
Desk Stand	15
Table Stand	£2 15
Floor Stand	£4 5
Floor Stand, Lightweight	£2 2

PICK-UPS

Goldring Turnover Model 165 (with twin sapphire) £3 . 0 . 3

Acos GP19 Head	£2 3
Acos GP20	£3 11
Decca X/M/8, 2 Heads	£7 0
Connoisseur with 1 head	£6 9
Do., Extra heads	£3 11
Wilkins & Wright	£7 10

B.T.H. GERMANIUM CRYSTAL DIODE

Complete with Blueprint and operating instructions

3/-

MORSE BUZZER OUTFITS

Consisting of a buzzer, a morse key and a battery compartment, all mounted on a polished baseboard. All parts high grade ex-Air Ministry. An excellent gift for a boy. Post free.

6/-

SOLDERING IRON

● The Perfect Small Soldering Iron. ● Adjustable Bit. ● Easy to Handle. ● Weight approx. 4 oz. ● Heating Time 3 min. ● 40 watt Economy Consumption. ● Voltage Ranges 100/110 v., 200/220 v., 230/250 v., other ratings available on request. ● Long Life and Efficiency. ● Replacement Elements and Bits always available. Just the convenient Iron required for intricate and fine soldering.

16/9

Electric Paint Stripper

A.C. and D.C.

SAFE . . . puts the heat just where it's wanted—nowhere else. **CLEAN** . . . no fumes—no messy filling up. **EASY** . . . a little practice and you're expert. **ECONOMICAL** . . . runs for 8 hours for 3d.

List 47/6 OUR PRICE 37/6 Post 1/3

"WONDER" HAND TOOL

6 TOOLS IN ONE

10/- Plus 1/6 post and pkg. (reduced from 20/-)

Punches, Bends and Shears Metal Strip, Rod and Angle. Every Handyman, Mechanic and Service Engineer needs one! 1,000 used!

Unique! Order TODAY!

High-power super-heat flame. PERFECT for Light Brazing, Tempering, Hard Soldering, Silver Soldg., Tinning, Sweating, etc. Fits into ordinary Gas Tubing. No extra air pressure. Full instructions.

2/6 post 6d.

PAINT SPRAYER

for easy spraying any liquid or paint. Gives fine finish to your car, bike, furniture, etc. Makes every man a Handyman.

Post 9d 15/6

AMERICAN type British made A.C.

Electric Paint Sprayer Tax free 75/- Post 2/-

RADIO BULLS VALVES
246 HIGH ST. HARLESDEN NW10

(Kindly mark envelope W.W.3).

FOR HIGH FIDELITY RECORDINGS

"SCOTCH BOY" TRADE MARK MAGNETIC RECORDING TAPE TYPE MCI-III

Careful design and rigid control in manufacture, provide the critical listener with a reliable hard-wearing tape that will help to get the very best results from any tape recorder.

MAGNETIC DATA

Coercivity . . . . . 240-260 Oersteds
Total Remanent Flux . . 0.4/0.5 lines ¼in. width
Uniformity throughout a reel . . . . . ±0.5 d.b.

FREQUENCY RANGE
50 c/s to 10 Kc/s at a playing speed of 7½ in./sec.

Medium coercivity gives a high signal output with an extended high-frequency response, whilst still retaining an easy erasure. Signal/noise ratio is high; transfer and distortion are negligible.

PLAYING TIMES (per track)

REELS	1⅞"/SEC	3¾"/SEC	7½"/SEC	15"/SEC
1200 Ft.	120 Min.	60 Min.	30 Min.	15 Min.
600 Ft.	60 Min.	30 Min.	15 Min.	7½ Min.
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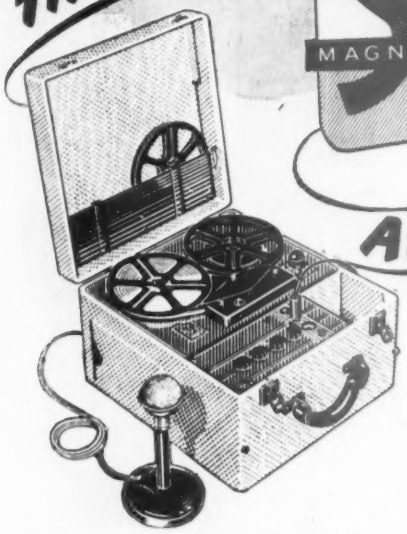

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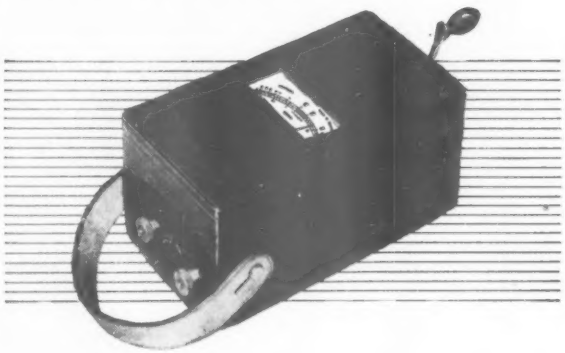

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70.	Excel Pro/Tape Desk	£75 0 0	£25 0 0	97/1
71.	M88 Type PMR1 Recorder	£150 0 0	£50 0 0	191/8
72.	Ferrograph Type A	£79 10 0	£26 10 0	100/-
73.	Vortexion Recorder	£85 0 0	£28 12 0	90/9
74.	CJB Portable Recorder	£119 0 0	£40 0 0	146/8
75.	Sound Mirror Portable	£79 10 0	£26 10 0	100/-
76.	Sound Mirror Table Model	£69 10 0	£23 10 0	88/2
77.	Simon Model 2B	£60 0 0	£20 0 0	76/8
78.	Simon Model 1A	£83 0 0	£27 13 8	105/-
79.	Wirek Magnograph	£65 0 0	£25 0 0	76/8
80.	Wirek Reporter	£59 0 0	£20 0 0	74/-
81.	Bradmatic Amplifiers	£62 0 0	£21 0 0	78/7
82.	Scophony Baird Mk. 2	£68 5 0	£22 15 0	86/3

TAPE RECORDING ACCESSORIES AND EQUIPMENT

		Cash Prices
83.	Bradmatic Circuits	5 0
84.	Bradmatic Plate Coil	9 0
85.	Bradmatic Oscillator Coil	9 0
86.	Bradmatic Bias Rejector Unit	12 6
87.	Bradmatic Mumetal Screens	4 6
88.	Bradmatic Tape Guides	5 0
89.	Bradmatic 5 RP Heads	£3 5 0
90.	Bradmatic 6RP Heads	£3 15 0
91.	Bradmatic 5E Erase Heads	£3 5 0
92.	Sound Mirror Tape, per reel	£1 5 0
93.	G.E.C. Tape, per reel	£1 10 0
94.	EMI Tape, per reel	£1 10 0
95.	Scotch Boy Tape, per reel	£1 15 0
96.	Collaro Tape/Rec. Motors*	£1 18 0
97.	Spare Spools	6 6
98.	Acos Microphone	£6 6 0
99.	Rothermel Mike	£3 0 0
100.	Reslo Ribbon Mike	£9 9 0
101.	Reslo Table Stand	£2 12 0
102.	Reslo Moving Coil Mike	£5 5 0
103.	B.S.R. FP.10, 1,400 r.p.m.	£1 18 0
104.	B.S.R. SR.1, 2,750 r.p.m.	£1 12 0
105.	B.S.R. SR.2, 2,750 r.p.m.	£1 5 0

* Left and right drive.

PICKUPS AND PICKUP HEADS AND CROSS-OVER UNITS

(H.P. Available over £10)

106.	Decca XMS with two Heads	£7 0 0
107.	Decca Hi-Fi Mag. Pick up Head	£2 19 6
108.	Connoisseur Pickup	£6 9 0
109.	Connoisseur Pickup Head	£3 11 8
110.	Connoisseur Pick-up Transformer	15 0
111.	Leak Ruby Standard or L.P.	£12 12 0
112.	Leak Diamond Std. or L.P.	£19 2 6
113.	Leak Pickup Transformer	£2 15 0
114.	Acos G.P.19	£3 11 5
115.	Acos G.P.20	£3 11 5
116.	Acos L.P. and Std. Heads	£2 3 4
117.	Acos Pickup Arm	£1 7 6
118.	Decca Pickup Arm	£1 7 6
119.	Collaro Pickup Arm	£1 5 6
120.	Chancery Crystal Pickup	£2 12 0
121.	Decca Crystal Pickup	£2 12 6

NOTICE

The policy of Classic Electrical is to supply only quality equipment of proven repute. There are no clearance bargains or ex-Government lines. Merchandise is thoroughly tested before despatch and guaranteed. Send for lists and details of your requirements if not given here.

NEW SHOWROOMS OPENING

We are opening additional showrooms for the demonstration of large-screen television, tape recorders, amplifiers, etc. Buses No. 12, 54 or 59A pass door. Nearest stations Norwood Junctn., E. Croydon, Woodside, or Addiscombe. Motorists make for Ashburton Park (Shirley Rd.).

THIS MONTH'S QUALITY-ECONOMY SUGGESTION

GRUNDIG "REPORTER"

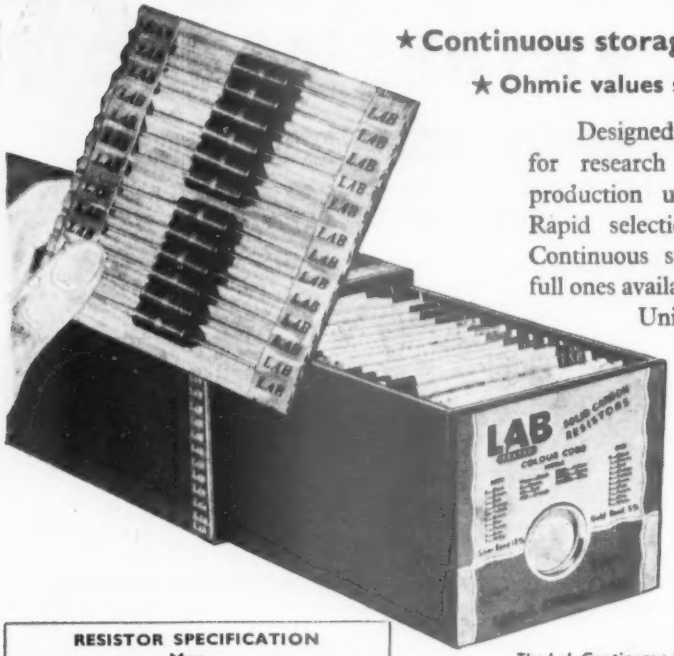
Outstanding amongst today's quality recording equipment, the Grundig Reporter offers facilities for recording phone calls, remote control by hand or foot, mixer unit for taking up to 4 recordings at once and a host of other attractive features. Completely portable. A.C. only, 110/125/220/240 v. With Hi-Fi mike.

75 gns. *or £28.15.0 deposit and 12 monthly payments of* **£4.15.10**

FOR QUALITY FIRST

THE CLASSIC ELECTRICAL CO., LTD. 352/364, LOWER ADDISCOMBE ROAD, CROYDON, SURREY. Telephone ADDiscombe 6061-6062.

ONLY the LAB unit has all these features...



★ Continuous storage ★ 700 resistors in a space 12" x 4" x 4"

★ Ohmic values separately carded ★ Finger-tip selection

Designed to provide a complete range of resistors for research and experimental laboratories and small production units. As easy to use as a card index. Rapid selection from 700 sorted and carded resistors. Continuous storage — empty cards merely replaced with full ones available from stock. The Lab Continuous Storage Unit is supplied FREE with initial purchase of

180 Type R Resistors (Order LSUC ½)
or 240 Type T „ (Order LSUC ¼)

THE LAB TESTED CONTINUOUS STORAGE UNIT

RESISTOR SPECIFICATION

Ref.	Type	Loading	Max. Volts	Range	Dimensions
T	½-watt	¼-watt	250	10 ohms to 10 megohms	⅜" × ⅝"
R	½-watt	1-watt	500		½" × ¾"

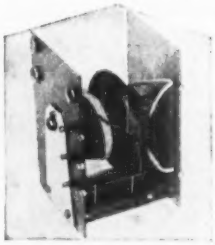
Tolerance available ±20%, ±10%, ±5%

The Lab Continuous Storage Units are available from your normal source of supply but more detailed information can be obtained from

THE RADIO RESISTOR COMPANY LTD.
50 ABBEY GARDENS, LONDON, N.W.8 · Telephone: Maida Vale 5522

"WEYRAD"

LINE FLYBACK E.H.T. TRANSFORMER



A very high efficiency transformer which will produce up to 13 kV. in a circuit employing an efficiency diode and a 300v. H.T. rail.

Width and linearity controls for the circuit are now in production.

"H" TYPE COILS

A complete range of miniature iron-cored coils which are produced in aerial, H.F. transformer and oscillator versions. Available in 7 bands giving continuous coverage from 12 to 2000 metres (25 mc/s-150kc/s).

P.5 TYPE I.F. TRANSFORMERS

Medium size — core adjustment from side of can. 465kc/s operation. Complete assembly wax dipped to prevent breakdown.

ILLUSTRATED CATALOGUE — 6d.

WEYMOUTH RADIO MFG., CO., LTD., CRESCENT STREET, WEYMOUTH.

ASK ARTHURS FIRST

Send your enquiries for all Radio and Electrical goods, especially those in short supply.

★ **NEW VALVES**
We have probably the largest variety of valves in the country. Let us know your requirements.

AVO METERS IN STOCK

Avo Model 7	£19 10 0
Avo Model 8	£23 10 0
Electronic Test Unit	£27 10 0
Electronic Test Meter	£40 0 0
Valve Characteristics Meter	£60 0 0
★ Cossor Oscilloscopes Models 1035	£93 10 0
„ „ „ 1049	£132 0 0

„Also full range Taylors Meters. List on request.

VALVE MANUALS

Mullard	5 0
Osram	5 0
Brimar No. 4	5 0
Mazda, Part 2	2 0
Mullard Valve Replacement Guide	2 6
Amateurs' Guide to Valve Selection by Mullard	1 6

Postage 6d each extra

Leak Point 1 Amplifiers	£28 7 0
Leak Pre-Amplifiers	£9 9 0
Leak Tuning Unit	£38 5 0
Woden output transformers for Williamson Amplifier	£6 12 0
Partridge	£7 5 3
Woden Choke P.C.F 12	£2 4 0
Wearite Tape Deck	£35 0 0
Grundig Tape Recorder	£78 15 0

Recording Tapes: E.M.I., G.E.C. and Scotch Boy, 35/- each

Ferrovoice Tape, 1,200ft. on 7in. spool 22/6 only (plus 9d. postage).

Terms C.O.D. or Cash with order. Goods offered subject to being unsold and to price alteration.

Arthurs EST. 1919
PROPS: ARTHUR GRAY, LTD.

GRAY HOUSE, 150-152 CHARING CROSS ROAD, LONDON, W.C.2
TEMple Bar 5833/4 and 4765. Cables: TELEGRAY, LONDON

Instruments for Research & Industry

MODEL 29

Twenty Million Megohmmeter

The Model 29 Megohmmeter is a direct reading instrument covering a range of 0.3 to 2 × 10^6 megohms. Internal test voltages of 85 and 500 are provided, but up to 1000 v. may be used from an external source. The instrument is extremely simple to operate and is being widely used for testing cables, condensers and dielectrics of all types.

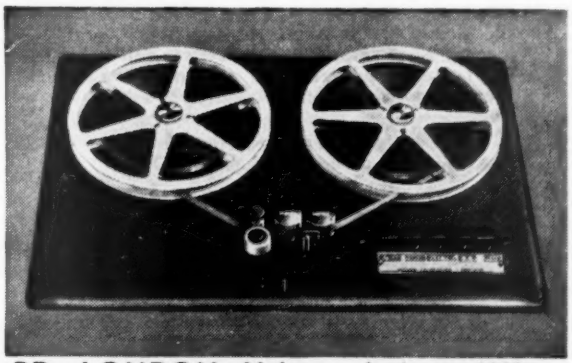
ELECTRONIC INSTRUMENTS LTD
RICHMOND · SURREY · ENGLAND

GET IT **"TAPED"** *ON THE* **NEW MOTEK K3 TAPE UNIT FROM HATFIELD RADIO**

Nothing comparable at near the price
Consider these features: ● 3 Collaro Motors
● Push button operation ● Electronic braking by push button ● High impedance twin track record and erase heads ● New improved fly-wheel and capstan machined to accuracy of 1/10 of 1 thou. in. eliminating "wow." ● Supplied with full instructions and suitable circuit for amplifier. ● Fully tested, and guaranteed for 12 months ● One hand operation, tape finds its own level ● Fast rewind without handling tape ● Fast forward without handling tape ● Tape speed 7½in. P.S., giving 1 hour on 7in. spool.

OUTSTANDING APPEARANCE
SUPERB PERFORMANCE
Made by **MODERN TECHNIQUES**

PRICE **16** GUINEAS



2 TAPE DESK AMPLIFIERS AVAILABLE. Both first class, and designed for the Motek K.3 unit **B.6.** At ..... **£15** Uses E.F.37, 6SN7, 6V6, 5Z4 and Magic eye, with 8in. speaker, or :

H.R.2 at **£9.15.0** or equiv. uses SP61, 6SN7, 6V6, 6V6 and 5Z4 and 6½in. speaker.
Both have oscillator for bias and erase, high and low gain inputs, free from hum. With ample gain, 6 months guarantee. Separate bass and treble boost.

REXINE PORTABLE TYPE CABINET
for Motek K3 and Amplifier, etc., **£4/17/6.** Spare reels, Scotch Boy Tape and Microphones at standard prices. Post and Packing 5/- extra.

Write for further details:—
HATFIELD RADIO, 78 STROUD GREEN RD., LONDON, N.4 *Archway 1593*
Callers Welcome

MODERN ELECTRICS LTD.,

164, Charing Cross Road, London, W.C.2. 'phone TEMple Bar 7587.

Export enquiries welcomed. *Immediate delivery from stock.* *Prompt attention to post orders.*

TAPE RECORDERS

SOUNDMIRROR
Table Model £69 10 0
Portable £74 10 0
SCOPHONY-BAIRD
New Model Mk. 2, £68 5 0
SIMPHONIC
New Model IA..... £83 0 0
" GRUNDIG " 2-Track
press-button control £78 15 0
WIREK
Portable Battery
Model..... £59 0 0

RECORDING TAPE

GRUNDIG
L.G.H., 1,200ft. £2 0 0
SOUNDMIRROR
Paper Tape £1 5 0
Spare Spool 6 6
E.M.I. H.60, 1,200ft. £1 15 0
E.M.I. H.60, 600ft.... £1 1 0
E.M.I. H.65, 1,200ft.... £1 15 0
E.M.I. H.50, 1,200ft.... £2 8 0
SCOTCH BOY
1,200ft £1 15 0
SCOTCH BOY, 600ft. £1 1 0
Spare Spools, 1,200ft. 4 3
Spare Spools, 600ft.... 3 3
E.M.I. H.57, 3,250ft. ... £6 0 0
SIMPHONIC
As advertised £1 15 0

VALVES
We are one of London's Largest Stockists — Please write for requirements.

RECORD REPRODUCING EQUIPMENT

DECCA
2-speed Motors, complete with turntable and Rubber Mat £3 18 6
3-speed, complete... £6 8 6
B.S.R.
3-spd. (Crystal T/O Hds.) £9 19 11
3-spd. (with 2 GP20 Hds.) £11 16 6
3-spd. (with 2 Decca Hds.) £13 18 6
3-spd. Auto-Mixer ... £17 17 0
GARRARD
R.C.80, less Head £16 8 6
R.C.75A, less Head ... £14 10 3
S.201.B. Variable 3-spd. Transcription Motor £24 12 6
CONNOISSEUR
3-spd. Deck £23 13 0
GOODMANS
Axiom 150, Mk. 2..... £14 1? 10
Audiom 60 ..... £12 6 3
WHARFEDALE
W.12/CS £14 6 0
Golden 10C.S.B. £9 0 5
Super 5 and 8CS/AL... £7 4 4
Bronze 10 ..... £5 6
Bronze 8in. £3 9 3
PLESSEY 10in. £1 5 0

TEST GEAR

AVO
Model 8 ..... £23 10 0
Model 7 (latest) £19 10 0
Uniminor £10 10 0
Electronic Meter £40 0 0
Wide Band Sig./Gen. £30 0 0
Valve Characteristic Meter..... £60 0 0
D.C. Minor £5 5 0
10kV. Multiplier for Model 8 ..... £2 5 0
Carrying Cases for Models 7, 8 and 40... £3 0 0
ADVANCE
H.1. (Sig./Gen.) £25 0 0
E.2. (Sig./Gen.)..... £28 0 0
J.1. New Model £35 0 0
COSSOR
Double Beam 1035 ... £93 10 0
Double Beam 1047 ...£132 0 0
TAYLOR
ALL NEW TAYLOR TEST GEAR IN STOCK AND AVAILABLE ON H.P. Send S.A.E. for Catalogue and Terms.

PICK-UPS

ACOS
G.P.20 (Std. or L.P.) £3 11 5
Spare Heads for above £2 3 4
DECCA
XL.T/O £3 19 2
XMS, Magnetic..... £7 0 0
CONNOISSEUR
Super Lightweight, LP/Std. £10 0 8
Spare Heads £3 11 8

LEAK PICK-UPS
Dynamic (Ruby Stylus) £12 0 8
Dynamic (Diamond Stylus) £18 8 4

MICROPHONES

ACOS
Mic 22 (Crystal) £6 6 0
Mic 22 (head only) ... £4 10 0
Mic inserts for above £1 9 6
Mic 16 (Crystal) £12 12 0
Mic 30 (Crystal) £4 4 0
SOUNDMIRROR
M/C with T/F ..... £ 7 7 0
LUSTRAPHONE
M/C with T/F.C.51... £5 15 6
M/C less T/F.C.51 ... £5 5 0
Heavy Table Base for above £1 1 0
Hand M/C with T/F CH.51 ..... £5 15 6
Hand M/C less T/F CH.51 ..... £5 6 0
RESLO M/C (Low Imp.) £6 0 0
RIBBON £7 5 0
FLOOR STAND
(Mic), 3 extensions £3 12 6
LEAK AMPLIFIERS
Point 1, TL12 ..... £28 7 0
Point 1, TL25 ..... £34 7 0
Control Unit £12 12 0
CONNOISSEUR AMPLIFIERS
Q.25 in Cabinet £48 10 0
Q.25, less Cabinet ... £41 5 0
" R.D. BABY DE LUXE "
Output 4 watts Incl., Pre-Amp £21 0 0

TAPE TABLES

SOUNDMIRROR—With Complete Instructions for Associated Amplifier ... £33 0 0, carriage extra.
WEARITE (limited stock), with Complete Instructions for Associated Amplifier, £35 0 0, carriage extra.

A WEEK'S FREE TRIAL

of this exceptionally fine recorder

So confident are we that you will be more than satisfied with the performance of

THE GRUNDIG REPORTER

that we offer you a Free Week's Trial to prove for yourself its excellence, and we agree to refund your money in full (less carriage) provided that the machine is returned to us in new condition within a week.

A really portable recorder that is ideal for use both in Home and Office

The price of the Grundig Reporter is 75 gns. including microphone and tape.

Terms: C.W.O. or C.O.D. H.P. Facilities.

Do not miss this opportunity of a Week's Free Trial.

For Technical Data see advertisement of Grundig (Great Britain) Ltd, on page 66.

THE HANDY SHOP (Established 1920)
109, CHURCH ST., CROYDON. 'Phone CRO. 5432

M. R. SUPPLIES, Ltd.

offer from stock the following brand new (or otherwise perfect) material. Immediate despatch—safe packing—all prices net.

ELECTROMAGNETIC COUNTERS. These are very superior counting devices operating from 20/24 volts D.C. or 40/50 volts A.C. Each unit contains two counters each counting up to 9999 and one or both can be used at the same time. Fine positive action, substantially made for years of service. Counting speed has been checked up to 1,000 per minute. In cylindrical housing, 5in. high, with 3in. window (for panel mount 3¼in. hole required). New, perfect, **37/6** (despatch 1/6).

SMALL GEAR BOXES. Double worm gear 300/1 reduction. In die cast housing approx. 2⅝in. × 2⅛in. × 2in., fine precision construction. Final shaft ¼in. dia. × 1¼in. proj., with two other take-offs (same ratio). Ball bearings, transmission up to 1/6th H.P. **42/6** (des. 1/6).

LONDEX RELAYS, type LQA from stock. Coil 230 volts A.C., with two mercury single-pole change-over switches, 15 amps., **75/-** (des. 1/6).

MINIATURE RELAYS. Two handy U.S.A. models, brand new. (A) Coil 350 ohms, 1-pole change-over, 1⅛in. × 1in. × ⅝in. (B) Coil 50 ohms, 3-pole make, 1¼in. × 1¼in. × 1¼in. Either **5/6** post free.

PORTABLE VOLTAGE-CHANGING TRANSFORMERS, 200/220/240 v. to 100/110 v. and vice-versa, loading 1,000 VA. In steel cabinet 8in. × 6in. × 6in., with carrying handle, and bushed cable entries. Brand new, **£8/10/-** (des. 5/6).

GEARED MOTORS. Very useful small universal A.C./D.C. units for operation on 220/240 v. Reversible and capable of speed control by external variable resistance. Average overall length 8in. Four models from stock: (A) Final speed, 100 r.p.m. (B) Final speed 50 r.p.m., either **£5/17/6** (des. 2/6). (C) Final speed, 10 r.p.m. (D) Final speed, 1 r.p.m.—these have double reduction, either **£6/18/6** (des. 2/6).

Also a few **KLAXON GEARED MOTORS,** 220/240 v. A.C. (Induction motor), final shaft speed 233 r.p.m., reversible, prime power 1/10th h.p., final torque 10.2 lb/in. Overall length 10in., dia. 3½in., shaft ⅜in., proj. ⅜in., **£5/17/6** (des. 2/6).

P.V.C. STRIPPER PLIERS (S.T.C.). Heated jaws remove all plastic insulation from cables cleanly and rapidly, with 200/250 v. transformer, **59/6** (des. 1/6).

A.C. VOLTMETERS, 2½in. flush panel mount, 0/300 volts A.C. 50 c. moving iron, new **32/6** (des. 1/-). **AMMETERS** (Thermocouple) 0/4 amps., new by Weston. With on-off switch, rectangular, 2in. dial, **7/6** (des. 9d.).

FRACTIONAL H.P. MOTORS. Batwin shaded pole, torque 800 grm/cms, 1,200 r.p.m. (constant), **42/6** (des. 1/6). Fracmo, universal A.C./D.C., 230 v. 1/75th H.P., 2,000 r.p.m., **37/6** (des. 1/6). **G.E.C. ONE-THIRD H.P. MOTORS,** 230/250 v. 50c 1 ph. Cap./Ind., ball-bearings, cont. rated, for horizontal or vertical mounting, 1,440 r.p.m. New, in makers' own individual packing cases, **26/18/6** (des. 5/-).

G.E.C. MINIATURE CRYSTAL CALIBRATORS. We have supplied quantities of these fine instruments to most of the important Radio Equipment makers, and have a few available at the same attractive price. Operation 200/250 v. A.C. For frequency calibration in 100 Kc steps from 100 Kc to 40 Mc/s. Modulation at 400 c/s switched in if desired. With vacuum mounted crystal, basic 100 Kc. Accuracy 0.001 per cent. Size 8⅛in. × 6⅛in. × 2⅛in. Brand new 12 guinea instrument for **£5/5/-** (des. 2/-). The calibrators are complete with leads, etc., and ready for use.

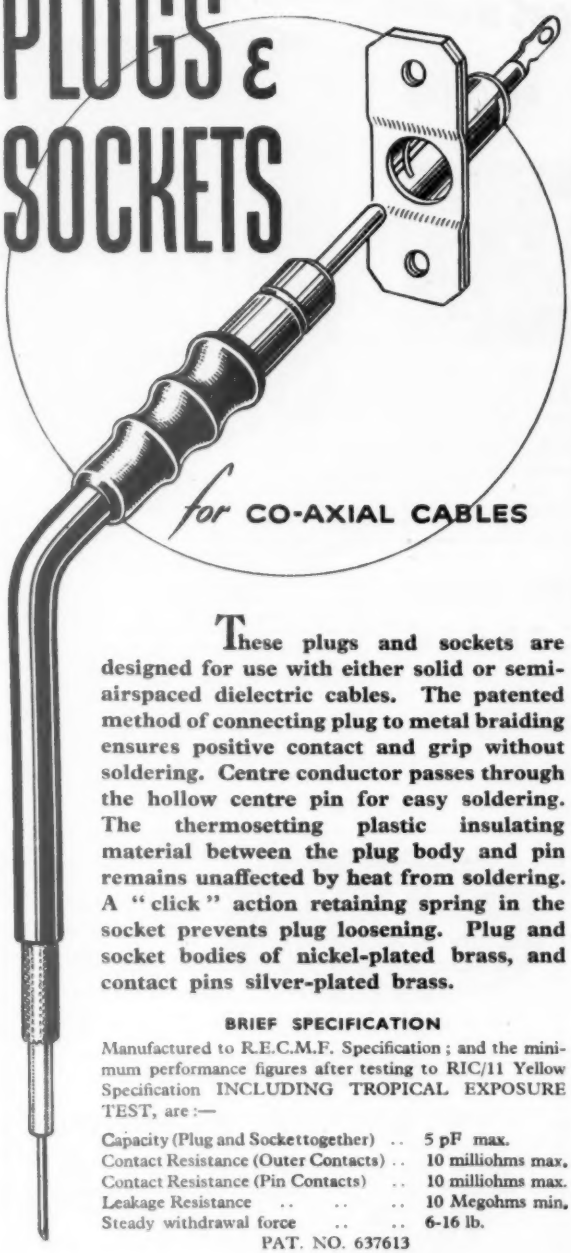
STUART CENTRIFUGAL PUMPS. All models from stock! Including the new No. 18 with 230/250 v. 50 c. 1 ph. induction motor, head 5/15 feet, 720/400 g.p.h. The perfect unit for continuous duty and minimum maintenance. **£11/15/-** (des. 5/-).

Rail despatch charges relate to England and Wales only.

M. R. SUPPLIES Ltd., 68 New Oxford Street, London, W.C.1

Telephone: MUSeum 2958

PLUGS & SOCKETS



for CO-AXIAL CABLES

These plugs and sockets are designed for use with either solid or semi-airspaced dielectric cables. The patented method of connecting plug to metal braiding ensures positive contact and grip without soldering. Centre conductor passes through the hollow centre pin for easy soldering. The thermosetting plastic insulating material between the plug body and pin remains unaffected by heat from soldering. A "click" action retaining spring in the socket prevents plug loosening. Plug and socket bodies of nickel-plated brass, and contact pins silver-plated brass.

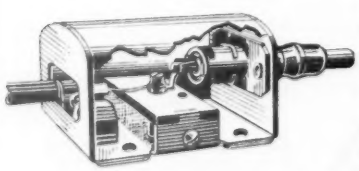
BRIEF SPECIFICATION

Manufactured to R.E.C.M.F. Specification; and the minimum performance figures after testing to RIC/11 Yellow Specification INCLUDING TROPICAL EXPOSURE TEST, are :—

Capacity (Plug and Socket together) ..	5 pF max.
Contact Resistance (Outer Contacts) ..	10 milliohms max.
Contact Resistance (Pin Contacts) ..	10 milliohms max.
Leakage Resistance	10 Megohms min.
Steady withdrawal force	6-16 lb.

PAT. NO. 637613

TELEVISION OUTLET BOXES



Illustrated is the type "S" for single point termination for skirting board or window frame mounting. Allows the receiver to be disconnected without interfering with wiring at the receiver or lead-in. With positive "click" ection socket.

Full details in Leaflet F/2.

ANTIFERENCE LIMITED

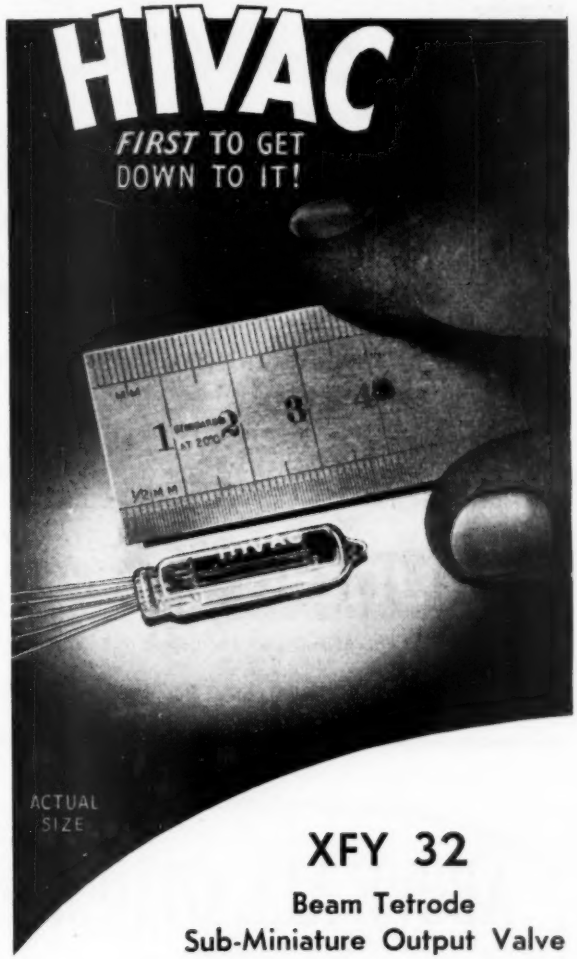
BICESTER ROAD · AYLESBURY · BUCKS.

C 1

SUB-MINIATURISATION

HIVAC

FIRST TO GET DOWN TO IT!



ACTUAL SIZE

XFY 32

Beam Tetrode
Sub-Miniature Output Valve

TYPICAL OPERATION

Filament Voltage	1.25	1.25	1.25 V.
Filament Current.....	12.5	12.5	12.5 mA.
H.T. Voltage.....	16.25	22.5	30 V.
Control Grid Voltage	0	-1.5	-2.75 V.
Power Output	1.1	2.7	6.0 mW.

The maximum cross-section is only 8 mm. x 6 mm. with a maximum glass length of 35 mm. and the nominal filament current is 12½ mA.

These features, in conjunction with the high efficiency of the XFY32 permit still greater saving in space whilst maintaining exceptionally fine performance.

HIVAC
THE SCIENTIFIC VALVE

Hivac Ltd. Telephone: HARrow 2855
GREENHILL CRESCENT, HARROW-ON-THE-HILL, MIDDLESEX

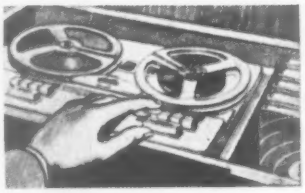
C

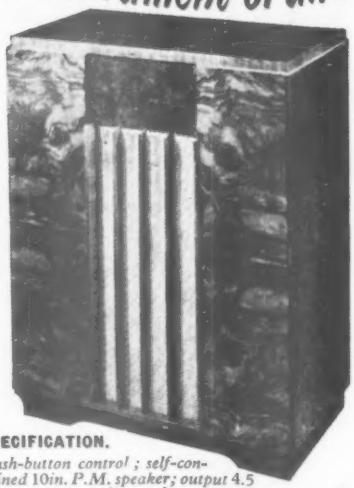
SOUND RECORDING? Here's the most wonderful instrument of all!

GRUNDIG

THE *Console* 700C TAPE RECORDER

Make sound recording an adventure! You can command—at the touch of a button—this most beautiful of all tape recorders. Record voices, music, sounds of every sort and summon them back whenever you like, at the touch of a button. Distinguish your home with the Console's superb cabinet, discover a new world of excitement in sound!





BUT WHY GRUNDIG PARTICULARLY?

BECAUSE of the brilliant simplicity of its controls.

BECAUSE of its magnificent performance. The 10in. high-flux speaker gives you superb tone.

BECAUSE of its two-speed selector giving one hour of music or *two* hours of speech, recording and playback.

Here is the unique condenser microphone as sensitive as the human ear.

SPECIFICATION.

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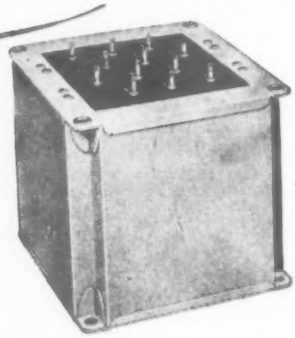

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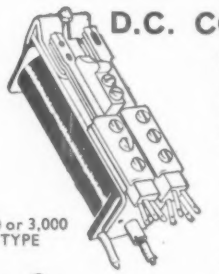

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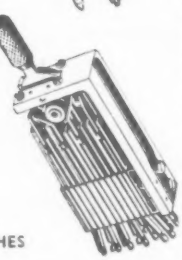

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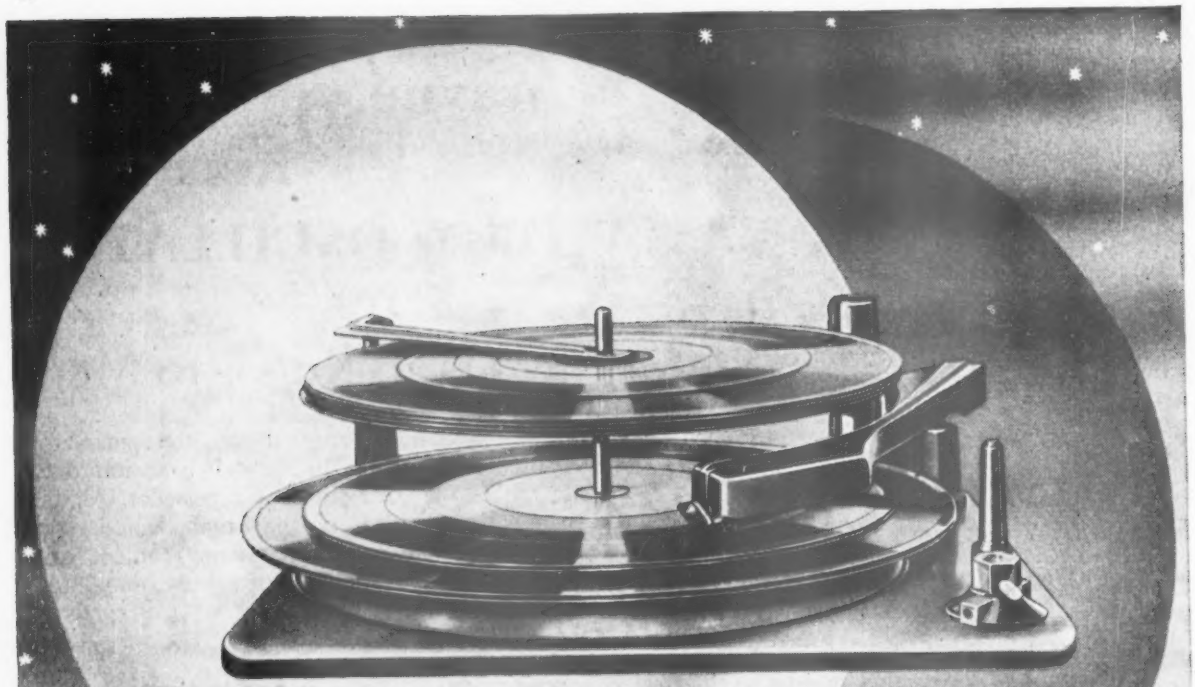

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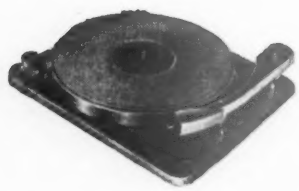

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

42nd YEAR OF PUBLICATION

Managing Editor : HUGH S. POCOCK, M.I.E.E.
Editor : H. F. SMITH

MARCH 1953

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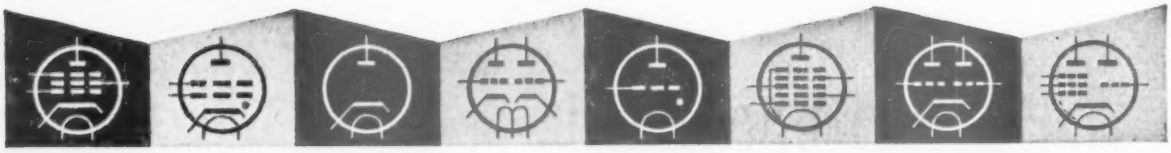


VALVES, TUBES & CIRCUITS

3. A PUSH-PULL AUDIO OUTPUT STAGE EMPLOYING TWO ECL80 TRIODE-PENTODES (contd.)

The triode section of one valve (V1A) functions as a voltage amplifier while the triode of the other valve (V2A) is used as a phase inverter. As this triode shares the same cathode as one of the output pentodes it is not possible to use the conventional type of cathode-coupled phase inverter. This has been overcome by connecting the triode as an anode follower.

In the arrangement shown in Fig. 1, the triode section V1A drives the pentode V1B in the same envelope, and V2A drives V2B. This mode of operation should not show any tendency to high frequency oscillation due to the capacitance between the pentode anode and triode grid being in the same bulb. An alternative and more stable arrangement is to drive V2B from V1A and V2A from V1B.

The cathodes of all four sections are connected together and returned to earth through a common impedance. If this impedance is too large it is possible for low frequency oscillation to occur. With a coupling capacitance, C1, of 0.01μF, the cathode bypass capacitance must be greater than 150μF to prevent oscillation. To allow an adequate margin of safety, a dry electrolytic capacitor of 250μF, 12V working, is recommended. The following table gives the approximate overall performance of the amplifier, using the components given in Fig. 1.

TYPICAL OVERALL PERFORMANCE DATA

V_b	...	170	...	200	V
R_{a-a}	...	15	...	15	kΩ
*$I_{k(o)}$	...	35	...	42	mA
*$I_{k\ (max.\ sig.)}$	...	38	...	46	mA
$V_{in\ (r.m.s.)}$	...	0.5	...	0.6	V
P_{out}	...	2.0	...	3.0	W
D_{tot}	...	3.0	...	3.5	%

* For two valves.

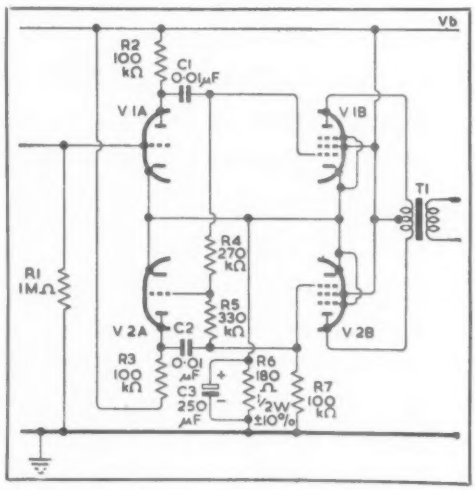


Fig. 1. Circuit diagram of amplifier

Reprints of this advertisement together with additional data may be obtained free of charge from the address below.

MULLARD LTD., Technical Publications Department, Century House, Shaftesbury Avenue, W.C.2.

MVM 219

Wireless World

MARCH 1953 VOL. LIX No. 3

Ethics of Home Recording

WRITING in our January issue with the diffidence that is proper in laymen who touch upon legal matters, we said there was no precedent for thinking that the recording of broadcasts for subsequent play-back in the domestic circle would amount to an infringement of copyright. We also argued that nobody suffers any loss through the home recordist's action. On p. 117 of this issue we print a comment on these views from Dr. T. E. Allibone, F.R.S., who was, we understand, the only scientifically qualified member of the Committee which advised the Government on copyright matters.

Much to our regret, Dr. Allibone does not find himself in agreement with either our law or our ethics. The legal point we leave to others to decide. As to the ethics of the matter, the recordist is not stealing anything; a part of his licence fee is paid to the copyright holders. To us, recording is no more than a delayed method of radio reception, which enables the recordist to hear what he wants at his own convenience.

Television Boosters

AS a matter of national economics, the cost of television transmitters is, with a broadcasting system like our present one, quite insignificant in comparison with that of the complementary receivers. This idea seems recently to have been accepted by the Government, which now gives it, more or less, as a reason why completion of the B.B.C.'s system must be deferred. But the principle seems to be accepted that, by way of compromise, it may be permissible to reinforce the signal in poorly served areas by means of low-powered "booster" stations. The argument is, apparently, that the stations themselves do not cost much, and—rather less convincing—that their operation will not greatly increase the demand for new receivers in the area served.

These boosters may be of two kinds. The first, which reinforces the signal of its parent station without frequency changing, might have a limited application in a country where parts of the terrain are extremely rugged. In Great Britain one can hardly envisage the use of that method, and it is safe to assume that a change of frequency will almost always be necessary. The two systems are being discussed* in the United States, where doubtless both will have their uses. There it is proposed that the term "booster" should be restricted to stations without frequency changing; the others should be called "satellites." That arbitrary nomenclature is likely to be confusing here, where at present all the B.B.C. stations are in fact satellites to a central source of programmes.

If there is any real objection to the term "booster," we might play for safety and adopt the word "repeater." "Relay," having other connotations, is ruled out. Whatever we call them, the stations may be defined as receiving their modulating signals by direct radio reception from a parent transmitter, in contra-distinction to those fed through a radio relay chain or r.f. cable. *Wireless World* hopes to publish some more detailed information on the possibilities of this economical method of signal reinforcement, which, we understand, has shown very promising results during tests.

Geared to Greenwich

ELSEWHERE in this issue we publish a note on proposed changes in the standard frequency transmissions sponsored by the National Physical Laboratory. When these changes were first mooted, we had visions of something much more spectacular; there was, in fact, a suggestion that a continuous stream of 1-c/s impulses were to be emitted.

Though this idea seems to have had an unsubstantial foundation, it is not entirely profitless to speculate on its possibilities. A continuous transmission of one-second pulses would make practicable a truly radio-driven clock—as opposed to radio-controlled. Time-keeping accuracy even up to the standard needed for astronomical purposes would be available to anyone who cared to set up a radio receiver arranged to actuate a simple and cheap clock mechanism.

* *Electronics*, January, 1953

D.C. Restoration in Television

Characteristics of the Circuit

By W. T. COCKING, M.I.E.E.

IT has now become almost the standard practice in television receivers to use as a sync separator a single r.f. pentode which is fed with the composite video signal through an RC coupling. This same signal is also fed to the cathode of the c.r. tube and is consequently of such polarity that the sync pulses are positive-going and the picture signal is negative-going. The main function of the sync-separator stage is to remove as completely as possible the picture content of the composite input signal and to provide an output of synchronizing pulses which is independent of the nature of the picture and which is also independent of the actual amplitude of the signal within certain limits. A secondary function is that the stage should remove as much noise as possible from the sync pulses.

The video stage with its coupling to the c.r. tube commonly has the form shown in Fig. 1. The coupling resistor is R and the inductance L is inserted to compensate for the effects of the unwanted stray capacitance C. It does this reasonably well over the range of video frequencies and over this range the impedance of the LCR network is substantially constant and of value R. At the higher end of the band the impedance does depart somewhat from this, it is true, but the effect is not important for present purposes.

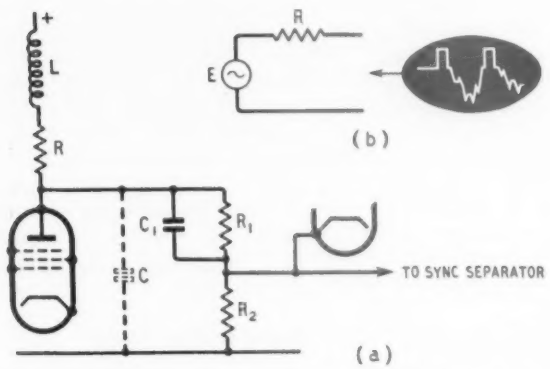


Fig. 1. Typical output circuit of a video stage (a) and its equivalent (b)

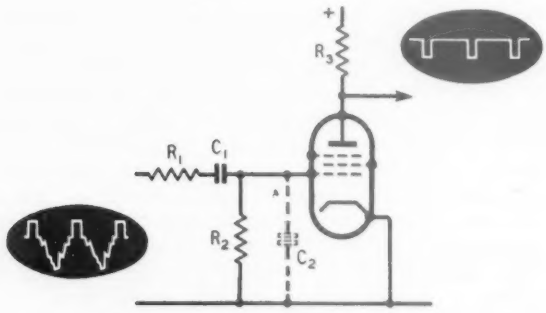


Fig. 2. Basic sync separator stage.

The potential-divider R_1 R_2 is included mainly to reduce the mean cathode potential of the c.r. tube so that its heater-cathode voltage is not excessive. The capacitance of C_1 is made large enough for it to be a virtual short circuit to R_1 for all the frequencies involved in the video signal. Commonly $R_1 = R_2 = 100\,k\Omega$, $C_1 = 2-8\,\mu F$, and R is about $3\,k\Omega$. The peak-to-peak signal amplitude is of the order of 40 V. For our present purposes we can replace the video stage of Fig. 1 (a) by the simple equivalent circuit (b) of a generator E, which provides a signal the same as the output of the real stage, in series with a resistance R, which is equal to the output impedance of the real stage.

The sync separator stage itself has the form of Fig. 2 in which R_1, R_2 and C_1 are commonly $10\,k\Omega$, $1\,M\Omega$ and $0.1\,\mu F$ respectively. In the transmission the tip of a sync pulse corresponds to zero carrier level and in the detector output it corresponds to the voltage (if any) which exists across the diode load with no signal. Similarly, if the video stage functions perfectly the tips of the sync pulses always occur at the same fixed voltage level in its output and all changes in the signal occur with reference to this level. Thus, in Fig. 1 (a), if the no-signal cathode potential of the c.r. tube is 100 V above earth and the output is 40 V p-p, black level will always correspond to some fixed level around 90 V and white to 60 V.

Passing the signal through an RC coupling removes its d.c. component and after the coupling it has no fixed level of reference. It is not simply that the fixed 100-V level of the above example is removed but that the signal excursions take place about any fixed level in a variable way so that black, white and the tips of the pulses no longer occur at fixed levels.

The way in which this occurs is very easily seen. Consider the simple circuit of Fig. 3. Initially let E be zero and C uncharged so that the whole circuit is quiescent. Then let the applied voltage change instantaneously from zero to $-E$, so that the potential of the upper terminal of the generator in Fig. 3 jumps from zero to $-E$ volts. The capacitor C cannot charge instantly and the only immediate result is for the voltage to drive a current of magnitude

$$i = \frac{E}{R_1 + R_2}$$

round the circuit. Electrons flow round the circuit in the direction shown by the arrow. The voltage

which instantly appears across R_2 is $iR_2 = v$ which is, of course,

$$v = E\frac{R_2}{R_1 + R_2}$$

The electrons flowing into the left-hand side and out of the right-hand side of C gradually charge it so that a potential difference appears across it with the polarity indicated. This opposes the applied voltage and reduces the current and so the output voltage v falls too. If the input voltage is not maintained for very long then the current and output voltage will not have altered very much by the time it returns to zero. The current will, in fact, have changed only from i to $i(1-\tau_1/T)$; that is, by the amount $i\tau_1/T$, where τ_1 is the time for which the input is maintained constant at E volts and $T = C(R_1 + R_2)$ is the time constant of the circuit. The output v falls proportionately, for it is always iR_2.

In Fig. 4 (a) the initial change of voltage is shown by AB and the maintained voltage by BC. In (b) is shown the resulting current i; the initial change is again denoted by AB and, greatly exaggerated, the changing current during τ_1 by BC. When the input returns to zero CD, (a), the capacitor C is left with a charge. As long as E is zero, C then discharges through R_1 and R_2. The change of current corresponding to the voltage change CD of (a) is shown at CD in Fig. 4 (b) and equals the initial change AB.

If E is maintained zero for a time τ_2 much shorter than τ_1, C must discharge proportionately less than it charged during τ_1. The change of current during τ_2 is, therefore, very small. When the input changes to $-E$ again, therefore, along FG, the current at G is only very slightly different from what it was at C. With successive cycles there is a gradual drift in the extreme values of current until an equilibrium condition is reached in which the charge gained by C during one period τ_1 exactly equals that lost by it during one period τ_2. When this occurs the shaded areas in Fig. 4 (b) are equal.

In the steady-state, when this equilibrium has been reached, a black television picture has for one line the waveform shown in Fig. 5 (a), the shaded areas being equal. For a white line the waveform is like (b), the shaded areas again being equal. It will be seen that both the tips of the sync pulses and black levels occur at very different voltages with reference to the zero level in the two cases. Since the limiter, which must be used to remove the picture signal, operates at a fixed level it cannot function on such a waveform.

In order to keep the sync pulses at a constant level, as they are in the input, it is necessary to discharge C (or alternatively to charge it to a fixed constant value) on every pulse. If in Fig. 3 there were a switch across C which closed every time the input became zero for the tip of a sync pulse, C would at once discharge to its initial zero level. Every output cycle would then be precisely like the input cycle, save for the small drop due to the charging of C during the period τ_1.

Unfortunately an ideal switch cannot be used and in d.c. restoration the practical equivalent is a diode of very appreciable resistance. Also it cannot usually be connected directly across C because different mean voltage levels at input and output are usually wanted. The diode is, therefore, connected across R_2. This has the effect of giving the circuit two time constants. One when the diode is conducting and another when it is not.

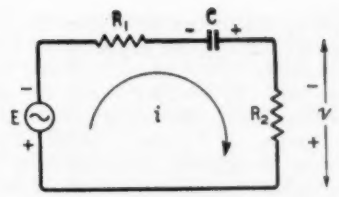


Fig. 3. Circuit arrangement of single RC coupling.

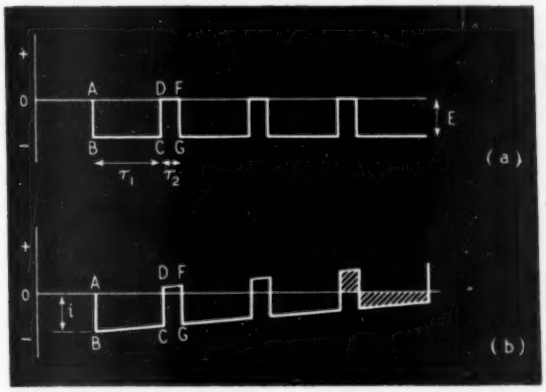


Fig. 4. Input waveform corresponding to line sync pulses (a) and the output of an RC coupling (b); the latter is also the current waveform since $v = iR_2$.

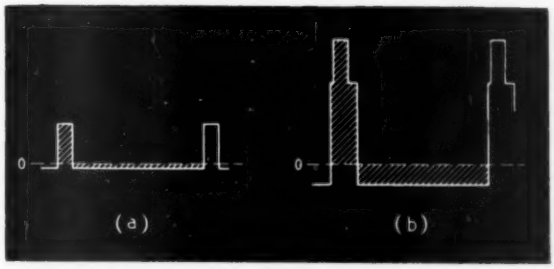


Fig. 5. Waveforms of one line in the steady-state during an all-black picture (a) and an all-white (b).

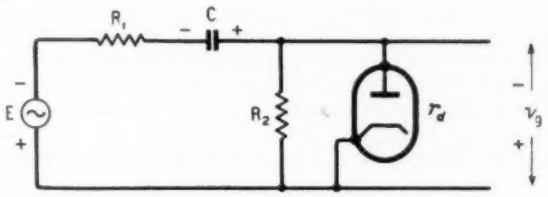


Fig. 6. The diode added to the circuit of Fig. 3 provides d.c. restoration.

The circuit becomes as shown in Fig. 6. For the moment we will idealize the diode and say that it does not conduct at all when its anode is negative to its cathode and it conducts with a constant resistance r_d when its anode is positive.

Starting with C uncharged the first part of the cycle ABC in Fig. 4 is precisely the same as before because the diode is non-conducting and does nothing. When the input changes to D [Fig. 4(a)], however, the diode conducts and C discharges through R_1 and r_d for the period τ_2 (R_2 being so high in comparison

with r_d that it can be neglected). Because τ_2 is much shorter than τ_1, the discharge of C in this interval was previously very small. Now, however, the time constant $T_d = C(R_1 + r_d)$ of discharge is much smaller than the time constant $T = C(R_1 + R_2)$ of charge. If T_d can be made so small that C can be almost completely discharged in the period τ_2, then the initial conditions on the next change of voltage FG are negligibly different from those on the first.

In a practical case R_2 may be 1 MΩ and C = 0.1 μF; if R_2 is much larger than R_1 the charging time constant is T = 0.1 second and the period τ_1 is nearly 90 μsec. During this time C is charged to $\tau_1/T = 90/100{,}000 \approx 1/1{,}000$ of the applied voltage. The discharge during τ_2 is exponential and is 99% complete if $\tau_2/T_d = 4.5$; now $\tau_2 = 10$ μsec, so T_d should be 10/4.5, say 2 μsec. The discharge time constant should thus be 1/50,000 of the charging time constant. As C is the same for both this means $R_2 = 50{,}000\ (R_1 + r_d)$ and if $R_2 = 1$ MΩ, we must have $R_1 + r_d = 20$ Ω.

It is quite impossible even to approach such a figure. The value of R_1 can rarely be less than 3 kΩ while r_d is of the same order of magnitude. In practice it may well be difficult to make $R_1 + r_d$ less than 10 kΩ. If R_2 were made 50,000 times this it would be 500 MΩ, which is equally impracticable.

It is not possible, therefore, in this way to discharge C every cycle and so it is not possible to achieve a fixed mean voltage across it for every cycle. All that can be done with d.c. restoration is to reduce in magnitude the changes which occur in the single RC coupling. They remain of the same nature but are of much smaller magnitude. A ratio of charge to discharge time constants of about 500 : 1 can be achieved in practice and is usually adequate. An appreciable change of the absolute black levels and sync pulse levels then occurs but as long as the change is small compared with the pulse amplitude itself it has little effect on subsequent limiting and that is the really important thing.

This is illustrated in Fig. 7 which shows, at (a) and (b) the output voltage waveforms with d.c. restoration. On an all-white signal (b) the sync-pulse tips are a little more positive and black level is a little less negative than with the all-black signal (a). When the picture changes from one to the other there is, of course, a slow drift from one condition to the other. If a white signal follows a black one, for instance, it starts off with all-black conditions with sync pulses and black level as in (a) and gradually drifts to (b).

In practice, it is important to keep the change of black level small and it is desirable to be able to calculate what it is. This calculation is easy enough

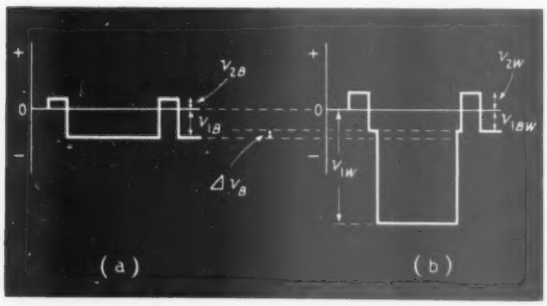


Fig. 7. Waveforms comparable to those of Fig. 5 but with d.c. restoration.

as long as the diode is considered as an open-circuit on the one hand and as a constant resistance r_d on the other. The changing voltage on C when this component has only a finite capacitance can be taken into account.

A real diode, however, has a resistance which is very far from constant; it has a resistance which changes with voltage from infinity to a low value of a few hundred ohms only. The diode, moreover, passes current until the anode voltage is more than about 1.3 V *negative* to cathode.

Because of this an exact analysis is impracticably difficult, and it is necessary to find an approximate method which will give reasonably accurate results. An actual diode characteristic is of the form sketched in Fig. 8. Now with a particular signal level, the tips of the sync pulses for an all-black signal will drive the diode to some point v_{2B} on its characteristic at which the current is i_{2B}. On an all-white signal the working point will change to v_{2W} at which the current is i_{2W}.

If a straight line AB is drawn through these two points it cuts the zero current axis at some voltage $-e_d$ and the line represents a resistance

$$r_d = \frac{v_{2W} - v_{2B}}{i_{2W} - i_{2B}}$$

If we represent the diode by a resistance r_d and a battery $-e_d$ in series, as in Fig. 9, then the representation is exact as long as we confine operation to the two voltages. If we depart from these voltages it becomes approximate, but if the departures are small the approximation is obviously a good one.

It is possible, therefore, to use the equivalent circuit of Fig. 9 to obtain a general solution for the change of black level between all-black and all-white pictures and the solution will be exact as long as C_1 is large enough. The determination of r_d and e_d is dealt with in Appendix 1 on the assumption that the characteristic of the diode can be represented by the exponential expression of equation (1.1). This law holds only for small currents and is really an approximate relation. It is treated in some detail in "Waveforms," M.I.T. Radiation Laboratory Series, Vol. 19, p. 63 (McGraw-Hill). The form of the characteristic is a straight line when plotted on semi-log paper and different diodes vary from one another only in the position of the line, not in its slope.

In Appendix 2 the performance of the d.c. restoring circuit is analysed. It needs little explanation here, for it is based on the requirement discussed earlier that the charge flowing into C during an inter-pulse period must equal that flowing out during a sync pulse. Equations (2.13) and (2.16) express one of the most important factors of a d.c. restorer, the change of black level between an all-white picture and an all-black one. With a perfect restorer the change would be zero.

These two equations can be combined. Doing this and also introducing values appropriate to the British television system we get, with slight approximation.

$$\Delta v_B = 0.83\,\frac{E_1\,(R + R_1) + 0.014R_2}{R + R_1 + R_2/10}$$

where, it must be emphasized, E_1 is the amplitude of the *picture* part of the signal and Δv_B is the change of black level between an all-white picture and an all-black. The accuracy is sufficient for most purposes.

In practice, R is usually about 3 kΩ and R_1 is around 10 kΩ, while R_2 is often 1 MΩ. With a picture

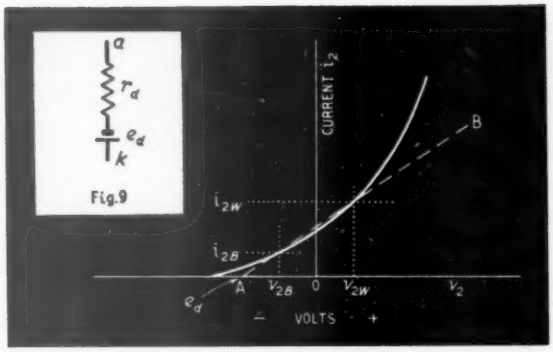


Fig. 8. General form of diode characteristic. If operation is confined to two distinct voltages v_{2B} and v_{2W}, it can be represented by a straight line AB. Fig. 9. (Inset) Equivalent circuit of diode for the conditions of Fig. 8.

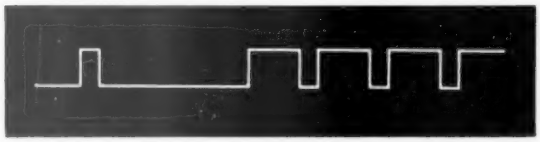


Fig. 10. Sync waveform during the frame pulses.

signal of 30 V p–p we find $\Delta v_B = 2.96$ V which, if the signal is reduced to 15 V, becomes 1.54 V. Since the sync pulse amplitude is about 5–10 V the variations of black level are quite appreciable fractions of it.

If R_1 is omitted there is a considerable improvement. In a 30-V signal Δv_B then becomes 0.85 V. If, as well, R_2 is increased to 4.7 MΩ the change of black level drops to 0.28 V. It is clearly important to keep R_2 as large as possible and $R + R_1$ as small as possible.

In the ordinary way $R + R_1$ cannot be less than about 3 kΩ, for this is the output impedance of the video stage. One could use an intermediate cathode-follower stage, it is true, and obtain an impedance as low as 100 Ω, but the expense of this would rarely be justifiable. In normal commercial receiver practice d.c. restoration is used only at the sync separator and the grid-cathode path of a pentode serves as the d.c. restoring diode while the other electrodes provide the limiting action. One limit is set by anode-current cut-off, and removes the picture content and the pulse variations near black level; the other limit is set by anode circuit "bottoming" and removes the variations in the tips of the pulses.

The resistance R_1 is often included and serves a double purpose. First, it largely removes the effect of the input capacitance of the sync separator, C_2 of Fig. 2, from the video stage, thus permitting R to be somewhat larger than would otherwise be the case. For this to be effective, R_1 must be several times R in value. Secondly, R_1 in conjunction with C_2 gives some slight integrating action. This sounds a bad thing in that it increases the rise time of the edges of the pulses. However, it is found that it reduces the effect of interference quite considerably. The effect depends on the type of interference, but in some cases the improvement in the synchronizing under noisy conditions is quite spectacular.

It appears, therefore, that the designer has most freedom in his choice of value for R_2. This is more illusory than real, however, for there are severe limits to its maximum value set by surface and other leakage. Many designers feel it unwise to use any resistance above 2 MΩ in value because of the danger of the effective value being a very variable quantity through surface leakage, the input impedance of valves and the leakage resistance of capacitors. Some designers place the limit lower and dislike anything above 1 MΩ. Others feel that they can control leakage better, perhaps, and will use values up to 5 MΩ; a few, a very few, will use values up to 10 MΩ.

Everything depends on the quality of the components used and upon the operating conditions. In the writer's view, 2 MΩ is a desirable maximum for the usual television conditions, but there is no doubt that one could go higher without serious trouble.

No account has so far been taken of the change of waveform which occurs during the frame fly-back interval. The waveform changes in the way shown in Fig. 10. On the first frame pulse the diode is conductive for 40 μsec instead of the 10-μsec of a line pulse; C_1, therefore, discharges more. Then during the following 10-μsec interval C_1 can charge less than on the 90-μsec intervals between line pulses. As a result there is a gradual shift of the waveform in a negative direction.

If we take black level on an all-black picture as a reference level, the black level during the frame sync pulses is more negative than this and the black level during an all-white picture is less negative. There are only some eight frame pulses, of course, and this is rather few for the steady-state to be reached; the magnitude of the shift is, therefore, likely to be in practice less than the steady-state shift. The maximum possible shift, however, is for the tops of the pulses to come very nearly to the grid-current cut-off point. This occurs if C_1 discharges completely during the pulses, which is unlikely, and then the pulse level is at the intersection of the grid-current curve with the load line for R_2.

The tips of the sync pulses will thus vary from a most-negative level during the frame sync pulses which is close to the grid-current cut-off point and may be

TABLE 1.

	$E_1 = 15$ V		$E_1 = 30$ V		Equation
	$R_1 = 0$	$R_1 = 10$ kΩ	$R_1 = 0$	$R_1 = 10$ kΩ	
r_d	2.175 kΩ	2.26 kΩ	1.085 kΩ	1.13 kΩ	2.15
α	48.3	16.4	61	17.7	
v_{1B}	– 4.9 V	– 4.71 V	– 9.85 V	– 9.48 V	2.10
v_{1WB} ..	– 4.62 V	– 3.9 V	– 9.4 V	– 8 V	2.12
Δv_B	0.282 V	0.8 V	0.446 V	1.48 V	2.13
$E - V_{CB} + e_d$	0.1015 V	0.287 V	0.162 V	0.532 V	2.4
i_{2B}	19.6 μA	18.8 μA	39.8 μA	37.8 μA	2.1
v_{2B}	– 0.215 V	– 0.212 V	– 0.145 V	– 0.15 V	1.4
e_d	– 0.2575V	– 0.2545 V	– 0.577 V	– 0.578 V	1.3
v_{2W}	0.4195 V	0.4165 V	0.739 V	0.74 V	2.9
v_{1W}	– 19.62 V	– 18.9 V	– 39.4 V	– 38 V	2.11

For $R = 3$ kΩ, $R_2 = 2.2$ MΩ, $E_1/e_1 = 3$, $\tau_2/\tau_1 = 0.1125$, $\tau_3/\tau_1 = 0.927$, $i_0 = 200$ μA.

taken as about -1.3 V to a most-positive (least negative) level during an all-white picture. This depends on the signal amplitude and the diode characteristics but is usually around -0.5 V to zero volts. If the following limiter is arranged not to respond to an input more positive than -1.5 V all the variations of the tips of the pulses should be cut-off under all conditions.

A second, more negative, limiting level is needed to remove the picture content. This must obviously be more positive than the black-level on an all-white picture. Table 1 shows the voltages calculated from the equations of the Appendices. In a 30-V picture signal, the black level is -8 V with $R_1 = 10\,k\Omega$ and $R_2 = 2.2\,M\Omega$. One must, however, allow a considerable latitude for contrast adjustment and, ideally, the synchronizing should be unaffected even when the signal falls to such a level that the picture is quite washy. With a 15-V signal, the black level changes to -3.9 V and one could arrange the cut-off point of the limiter at, say, -3.5 V. On this basis the limiter will be designed to pass between the limits of -1.5 V and -3.5 V, but not to respond to signals more positive or more negative than these.

So far the capacitor C_1 has been assumed to be infinitely large. For this to be approximately true it is necessary for C_1 to be large enough for its charge to change negligibly during any one period of the waveform. If we take a 1% change as permissible we have $t/T = 0.01$ when t is the time and T is time constant. During a line interval t is 90 μsec and $T = C_1R_2$. The general formula becomes $C = 100t/R$ in pF, μsec and MΩ.

For the line interval $C = 100 \times 90/2.2 = 4{,}100$ pF $= 0.0041\ \mu$F with $R_2 = 2.2\,M\Omega$. For the line sync pulse $t = 10$ μsec and the resistance is $R + R_1 + r_d$, say 14 kΩ, so $C = 100 \times 10/0.014 = 71{,}500$ pF $= 0.0715\ \mu$F. During the frame pulse intervals of 10 μsec the resistance is 2.2 MΩ and C need be only $0.0041/9 = 0.00045\ \mu$F, but during the frame pulses themselves, 40 μsec, when the resistance is 14 kΩ, C should be $0.0715 \times 4 = 0.286\ \mu$F. The conditions are thus substantially met if C_1 is 0.3 μF. In practice C_1 is not usually as large as that and is rarely more than 0.1 μF. This meets the requirements except during the frame pulses, but even then the departure from them is quite small.

APPENDIX 1.

The diode characteristic is assumed to be

$$i_2 = i_0\epsilon^{11v_2} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (1.1)$$

where i_0 is the diode current at zero voltage.

On all-black and all-white signals respectively the diode is driven during the sync pulses to the voltages v_{2B} and v_{2W}, Fig. 7, for which the currents are i_{2B} and i_{2W}. For these two voltages only the characteristic is that of a resistance r_d in series with a battery e_d as shown in Fig. 9. In Fig. 8 is shown how the line representing the resistance cuts the diode curve at the two operating points. The resistance is

$$r_d = \frac{v_{2W} - v_{2B}}{i_{2W} - i_{2B}} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (1.2)$$

and the battery is

$$e_d = i_{2B}r_d - v_{2B} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (1.3)$$

From (1.1)

$$v_2 = 0.09 \log_\epsilon i_2/i_0 \quad .. \quad .. \quad .. \quad .. \quad (1.4)$$

$$\therefore \quad r_d = \frac{0.09 \log_\epsilon(i_{2W}/i_{2B})}{i_{2W} - i_{2B}} \quad .. \quad .. \quad .. \quad .. \quad (1.5)$$

APPENDIX 2.

During the sync pulse of duration τ_2 the equivalent circuit is Fig. A.1, where E is the source voltage at the tip of the sync pulse, V_C is the mean voltage on the coupling capacitor and r_d and e_d represent the diode. Let $r_2 = R + R_1 + r_d$. The current is

$$i_2 = \frac{E - V_C + e_d}{r_2} \quad .. \quad .. \quad .. \quad .. \quad (2.1)$$

During the picture period of duration τ_1 the equivalent circuit is Fig. A.2, where V_S represents the signal voltage. The diode is inoperative. The current is

$$i_1 = \frac{E - V_C + e_d - V_S}{r_1} \quad .. \quad .. \quad .. \quad (2.2)$$

where $r_1 = R + R_1 + R_2$.

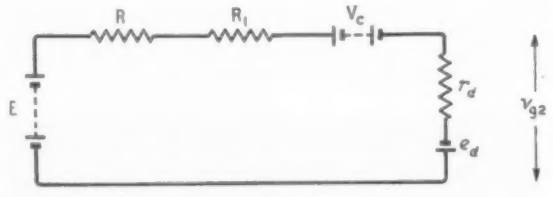


Fig.A.1

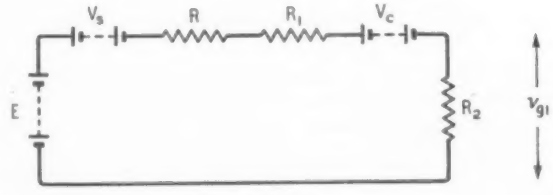


Fig.A.2

During a black picture $V_S = e_1$ for the whole period τ_1; therefore, i_1 is constant and of value

$$i_1 = \frac{E - V_C + e_d - e_1}{r_1} \quad .. \quad .. \quad .. \quad .. \quad (2.3)$$

It is necessary to have $\tau_1 i_1 + \tau_2 i_2 = 0$ in the steady state, hence

$$E - V_{CB} + e_d = \frac{e_1}{1 + \alpha} \quad .. \quad .. \quad .. \quad .. \quad (2.4)$$

where $\alpha = \frac{\tau_2 r_1}{\tau_1 r_2}$ and the extra subscript (B) indicates that the value of V_C is that for an all-black picture.

In the case of an all-white picture V_S has the value $e_1 + E_1$ for a period τ_3 and e_1 for a period $\tau_1 - \tau_3$. Consequently, the mean value of i_1 is

$$i_1 = \frac{E - V_C + e_d - e_1 - E_1\tau_3/r_1}{r_1}$$

and in the steady state we get

$$E - V_{CW} + e_d = \frac{e_1 + E_1\tau_3/\tau_1}{1 + \alpha} \quad .. \quad .. \quad .. \quad (2.5)$$

where the subscript (W) indicates the value of V_C for an all-white picture.

The anode voltage during a sync pulse is

$$v_2 = i_2r_d - e_d \quad .. \quad .. \quad .. \quad .. \quad .. \quad (2.6)$$

and during a picture interval is

$$v_1 = i_1R_2 \quad .. \quad .. \quad .. \quad .. \quad .. \quad (2.7)$$

By straightforward substitution we get

$$v_{2B} = e_1 \frac{r_d/r_2}{1 + \alpha} - e_d \quad .. \quad .. \quad .. \quad .. \quad (2.8)$$

$$v_{2W} = (e_1 + E_1\tau_3/\tau_1) \frac{r_d/r_2}{1 + \alpha} - e_d \quad .. \quad .. \quad (2.9)$$

$$v_{1B} = -e_1 \frac{R_2}{r_1} \frac{\alpha}{1 + \alpha} \quad .. \quad .. \quad .. \quad .. \quad (2.10)$$

$$v_{1W} = -\frac{R_2}{r_1}\left[e_1\frac{\alpha}{1+\alpha} - E_1\frac{\tau_3/\tau_1}{1+\alpha} + E_1\right] \quad .. (2.11)$$

$$v_{1WB} = -\frac{R_2}{r_1}\left[e_1\frac{\alpha}{1+\alpha} - E_1\frac{\tau_3/\tau_1}{1+\alpha}\right] \quad .. (2.12)$$

where v_{1WB} represents black level on an all-white picture. The values of V_s used in developing these equations are, of course, the peak values e_1 and E_1.

The change of black level is

$$\Delta v_B = v_{1WB} - v_{1B} = E_1\frac{\tau_3}{\tau_1}\frac{R_2}{r_1}\cdot\frac{1}{1+\alpha} \quad .. (2.13)$$

This is the maximum change of level that can occur with any change of picture content.

The value of r_d can be computed from equation (1.5) of Appendix 1 with the aid of (2.1), (2.4) and (2.5), giving

$$r_d = \frac{(R + R_1 + r_1\tau_2/\tau_1)\dfrac{0.09}{E_1\tau_3/\tau_1}\log_e\left(1 + \dfrac{E_1}{e_1}\cdot\dfrac{\tau_3}{\tau_1}\right)}{1 - \dfrac{0.09}{E_1\tau_3/\tau_1}\log_e\left(1 + \dfrac{E_1}{e_1}\cdot\dfrac{\tau_3}{\tau_1}\right)} \quad (2.14)$$

For the British television system $\tau_2/\tau_1 = 0.1125$, $\tau_3/\tau_1 = 0.927$, while in the signal as transmitted $E_1/e_1 = 2.33$. Allowing for the loss of sync pulse amplitude in the detector, however, $E_1/e_1 = 3$ is a more probable value at the receiver output. With these values

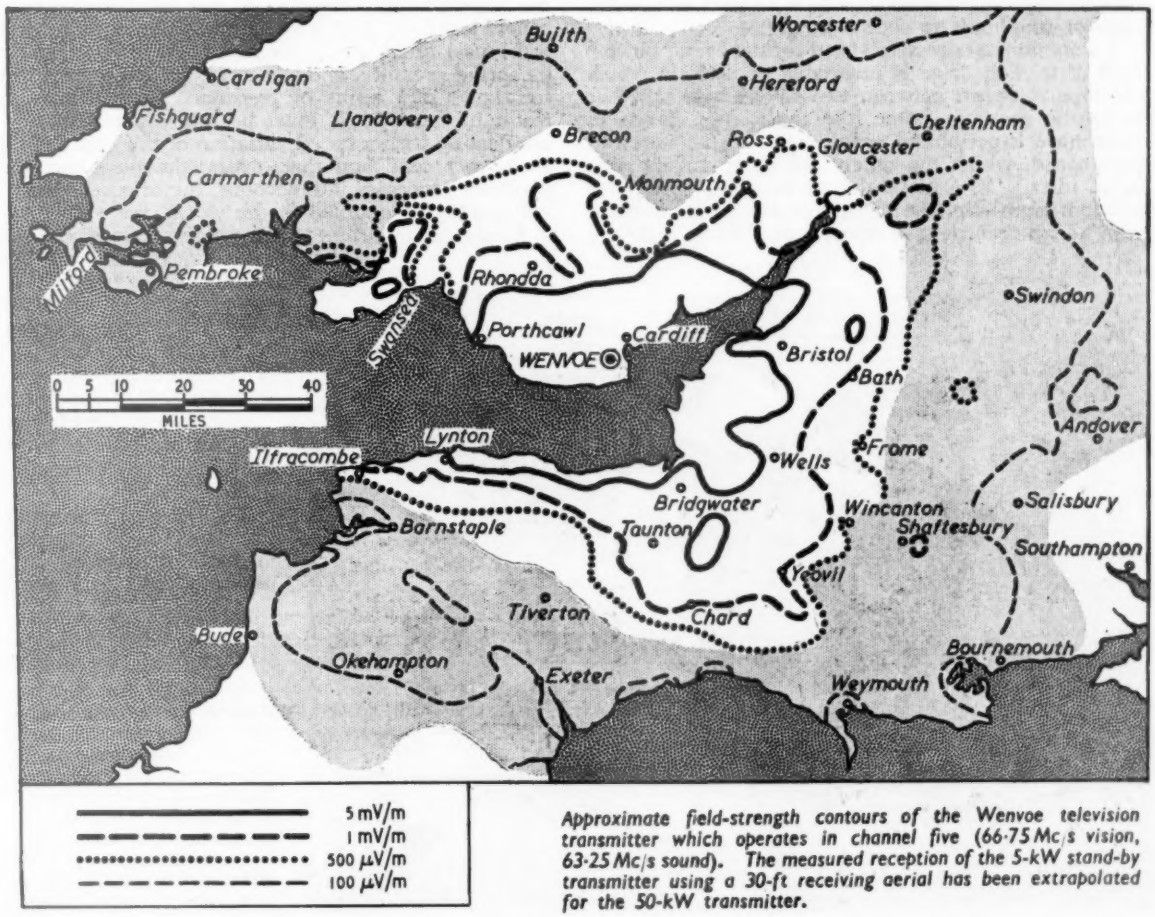
$$r_d = \frac{[1.1125\,(R + R_1) + 0.1125\,R_2] \times 0.129}{E_1 - 0.129} \quad .. (2.15)$$

WENVOE SERVICE AREA

WHEN the high-power (50-kW) Wenvoe television transmitter was brought into service towards the end of December, nearly 4.5 million people in Wales and the West Country came within its service area. This brought the percentage of the country's population within the areas served by television transmitters to over 78 per cent. The approximate population coming within the 100 μV/m contour of each of the five transmitters (in order of opening) is Alexandra Palace (London), 11,558,000; Sutton Coldfield (Midlands), 6,909,000; Holme Moss (North of England), 13,384,000; Kirk o'Shotts (Scotland), 4,022,000; and Wenvoe (Bristol Channel), 4,494,000. This gives a total of nearly 40.4 million, which is approximately 78.5 per cent of the country's population, according to the 1951 census.

The area within which consistently good reception of television transmissions can be expected naturally depends upon terrain, height of receiving aerial and intensity of electrical interference. This map showing the estimated field-strength contours for the 50-kW Wenvoe station has now been prepared by the B.B.C. and will serve as a rough guide to reception conditions in the area.

The field-strength at any given place may differ from the figure given on the contours (which represent average values) by as much as ± 10 db. In the shaded area considerable fading may be experienced.



Approximate field-strength contours of the Wenvoe television transmitter which operates in channel five (66·75 Mc/s vision, 63·25 Mc/s sound). The measured reception of the 5-kW stand-by transmitter using a 30-ft receiving aerial has been extrapolated for the 50-kW transmitter.

Designing a Tape

Part 1.—Tape Mechanisms and Recording Heads

By J. M. CARTER, B.Sc.*

In this series of articles, it is proposed to examine the problems arising out of the design and construction of a high-quality magnetic tape recorder and to outline some specific means for their solution. The text is therefore written more from the standpoint of a development engineer dealing with practical difficulties than from that of the research worker concerned with theoretical concepts and possibilities. Constructional details and actual circuit values will be included for those parts which can be made without special tools or equipment.

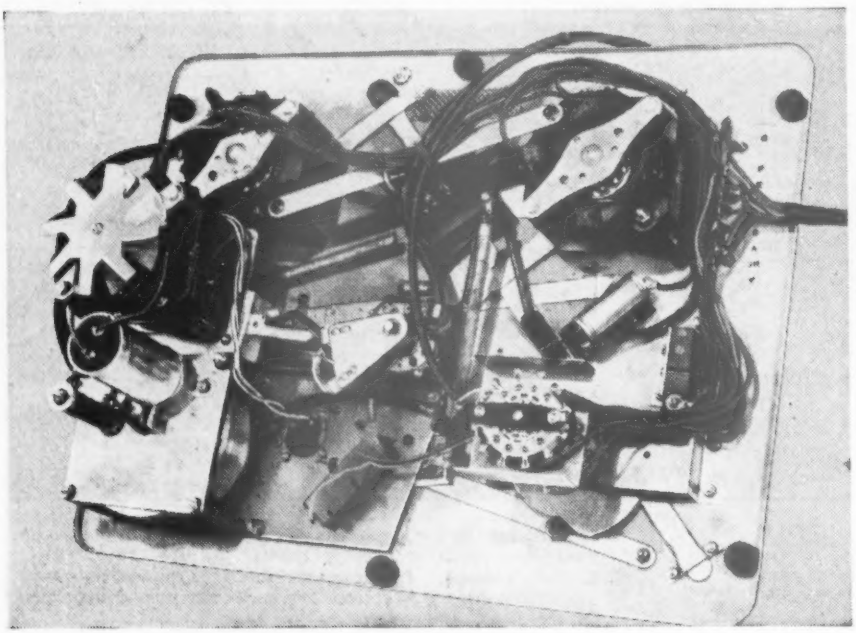
THE most important parts of a tape recorder, and those also which give the most trouble in manufacture, are the tape driving and spooling mechanism and the recording and playback "heads." With the former, the chief difficulty is that of transporting the tape over the heads at an absolutely constant speed, any irregularity immediately manifesting itself as either a low-frequency "wow," giving an undesirably tremulo effect to the reproduction, or a higher-frequency "flutter" which imparts noticeable edge or roughness to speech or music.

To obtain the necessary speed constancy, a "pinch" type of friction drive is invariably applied, in which the tape is drawn between two rollers held together by spring pressure. One (the capstan) is driven so as to have a peripheral speed equal to the required tape speed, whilst the other (the pinch roller) runs as an idler. To achieve the necessary traction with freedom from slip, the capstan must have a surface with a high coefficient of friction, and yet be perfectly true and smooth. A metal core with an accurately ground Neoprene rubber "tyre" has been found very satisfactory in this respect, with the reservation that some form of lever or cam movement is fitted to lift the engaging metal roller clear during stationary periods and so prevent any tendency for "flats" to form.

Whilst it is obvious that the capstan must be ground concentric to within the finest possible limits, it may not appear so important to do this also for the pinch roller; however, if this is eccentric the capstan, over some part of its revolution, will be lifting it against its spring pressure, and the increased effort incurred, translated into terms of resistance to motion, may result in "wow." It must be remembered that we are dealing with a speed variation of the order of 0.1 to 0.2 per cent, and that, taking the recording and playback processes into account, the original "wow" will always be doubled in the worst case.

Almost as important as the concentricity of capstan and pinch roller is the quality of the bearings on which they are mounted. Any slight variation in friction over any one part of a revolution will react unfavourably on the "wow," which means that the bearings must be of the highest possible quality.

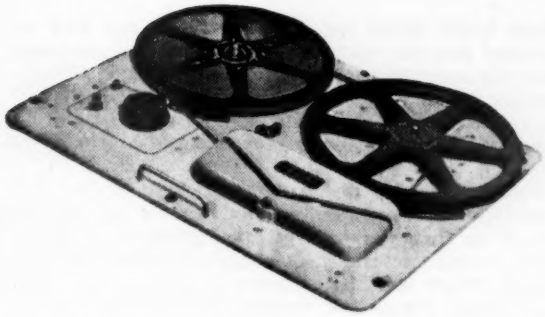
To assist in smoothing out any high-frequency fluctuations in speed, it is usual to have a flywheel



General view of underside of the "Wearite" Tape Deck. Separate motors are used for the capstan, the supply reel and the take-up reel. Control of the mechanisms is effected principally by a rotary switch to which all necessary mechanical movements are coupled by a system of cams and levers.

* Wright and Weaire Ltd.

Recorder



mounted either on the capstan spindle or integral with the capstan itself. The whole assembly should be dynamically balanced and, because of its extra mass, mounted on ball races.

The actual drive from the motor spindle to the flywheel-capstan combination is most easily effected by an intermediate rubber-tyred idler wheel, spring-loaded between a lightly knurled pulley on the motor shaft and the rim of the flywheel. The very small amount of slip in such a combination is acceptable for all but the most stringent requirements; for example, where the running time must be within, say, one second in thirty minutes. This type of drive has several advantages over the alternative direct (capstan on motor spindle) method. First, the diameter of the capstan is not fixed by the motor speed and its size may be fixed by other considerations, such as optimum traction, ease of manufacture, etc. By "stepping" the motor pulley diameter, the capstan speed can be arranged to have two or three fixed values, by simply moving the intermediate idler up and down, or by engaging alternative intermediate wheels.

Finally, it is possible to keep the capstan motor, with its external magnetic field, away from the immediate proximity of the playback head. Different motors vary widely in the frequency components and magnitude of their external field, which is dependent upon the working flux density, the rotor design and other factors, and it can prove to be very troublesome.

Three-motor Drive

The idea of employing additional separate motors for both the take-up and supply reels is becoming increasingly popular, and, where the small increase in weights is not a major consideration, has much to recommend it on the score of mechanical simplification, reliability and flexibility. The "Wearite" Tape Deck, for example, employs such a three-motor drive, and has an interesting method for switching the motors in the various operations such as playback, record, wind-on and wind-back. The normal direction of rotation of the supply reel motor is clockwise and that of the take-up reel motor anti-clockwise, and both are wound for a normal running voltage of 150. On "Playback" and "Record," the mains voltage of over 200 is applied across both motors in series, and, in addition, a shunt resistor is switched across the supply reel motor to reduce its terminal voltage. The take-up reel motor then has approximately its normal running voltage applied, and, working in a partially stalled condition, takes up the tape issuing from the capstan, whilst the supply reel motor, running at a reduced voltage and also stalled, exerts a reverse pull on the tape being unwound from the reel and keeps it taut. On the "Wind-on" and "Wind-back" positions, the full mains voltage is switched across the relevant motor, the other running free, and as this amounts to a 66 per cent short-duration overload, a very fast wind, even with the new 8½in reels, is obtained.

The method of braking the reels, especially during the fast wind-on and wind-back operations, is important and it is obvious that the reel from which the tape is being unwound should have the greater braking torque applied. A very neat and simple form of mechanical braking, fulfilling this condition, consists of semicircular rubber brake shoes bearing externally on the small drums which normally support the reels.

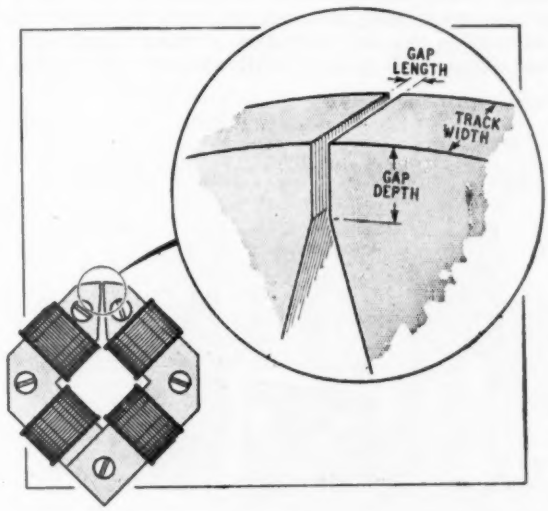
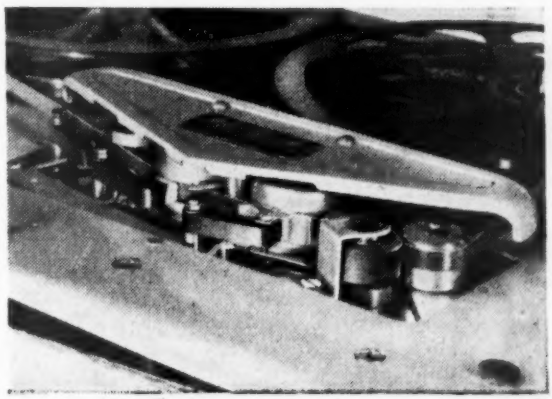


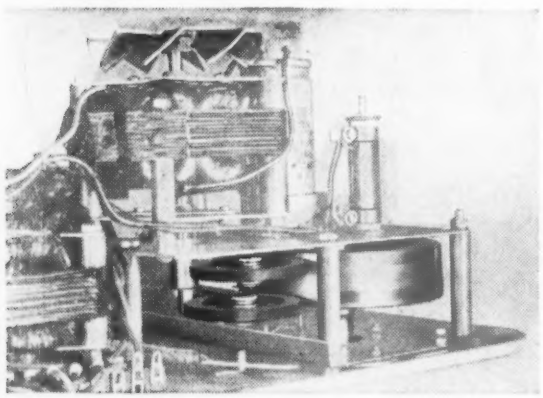
Fig. 1. Twin track record/playback head showing diagramatically the important dimensions of the gap. In both sketches the gap length has been much exaggerated.

Head and capstan assembly showing (right to left) pinch roller, capstan, record/reproduce head, erase head and tape-operated automatic switch.



These brake shoes are pivoted at one end and so arranged that they each tend to wrap around the drum when the appropriate reel is unwinding. In this direction the braking torque is much greater than that in the counter direction in which the driven reel will be rotating, and so the necessary differential braking is obtained.

Turning now to the question of head design and manufacture it is perhaps obvious that a full discussion of the theory and the practical problems involved would require several such articles as this, and only a brief review will be attempted to indicate the principle design points and outline the necessary manufacturing processes. To deal first with the choice between twin-track or full-width track heads, for practically all home recorders and semi-professional equipments, the twin-track head is to-day in universal use, as it has the enormous advantage of doubling the playing time per reel when facilities for "editing" the tape are not required. If editing is desired, only one track need be used, which means that the only real disadvantage is the reduced output (theoretically 6db) from the twin-track head, as compared with the full-track head, and as this only becomes of major significance when signal/noise ratios of 60db and over are sought, as in the best professional broadcasting equipment, it is far outweighed by the attendant advantages.



Capstan flywheel, twin idler wheels and "stepped" motor spindle giving alternative tape speeds of 7½ and 3¾ in/sec.

Semicircular rubber brake shoe on one of the drums supporting the tape reels motor spindles.

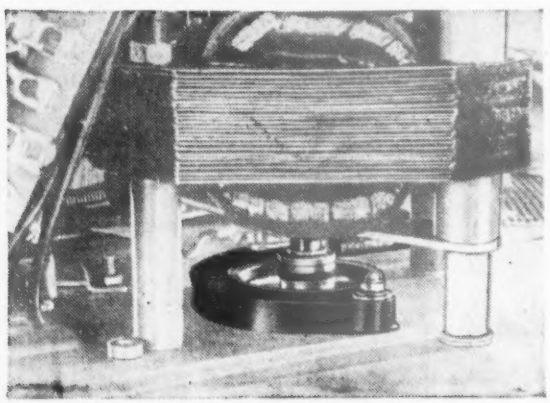


Fig. 1 shows the main features of a commercial record/replay head suitable for twin-track operation. For a good frequency response the effective gap (as distinct from the physical gap) should not exceed 0.0005in. A gap of 0.0003in is a better target. In addition it must be clearly defined, have straight parallel sides and be at right angles to the centre line of the tape if it is to line up with other instruments and play back their recordings with no loss in high frequencies. This "gap tilt" effect is also often overcome by mounting the head so that it can be rocked slightly from side to side while a standard high audio frequency is played back, the head being finally clamped at that angle which results in the maximum output. The adjustment is quite sharp; for example, with a wavelength of 0.001in corresponding to a frequency of 7,500 c/s at 7.5in/sec, a head tilt of half a degree between the line of the gap and the original recording results in a loss of 17db.

Also of vital importance to the general characteristics of the head is the depth of the gap (Fig. 1), which appears to have an optimum size for maximum "pick up" and minimum distortion as well as determining the correct bias and recording levels. Mumetal, or some such high-permeability material is practically essential for the head laminations which must be kept thin (and insulated) to reduce losses. As is well known, such materials suffer a considerable loss in permeability when cut, ground or even bent, and must be re-annealed after mechanical finishing. The construction of the erase head is essentially similar to that of the record and playback head, the main difference being in the smaller winding turns and the larger gap, which is not particularly critical, an average value being from 0.003 to 0.005in.

Tape Contact

An important feature in connection with the heads is the use of small "pressure pads" to ensure that the tape is in intimate contact with the surface of the head in the gap region. This is necessary because of the extremely small "spread" of the magnetic field from the head when recording, and from the tape when playing back. If contact is poor, wild variations occur in the amplitude of recorded constant tones, especially at the higher audio frequencies, and with many present-day tapes the effect can be cured only by the use of a pressure pad. The reason for this lies in the "backing," i.e., the 0.002-in thick cellulose-acetate strip on which the coating is deposited. If this is slightly concave or is overstretched along any edge, good contact over the full width of the head laminations is lost, the effect being worsened by the double loss on playback and record.

From this short introductory review it will be evident that the average enthusiast wishing to construct a high-quality instrument entirely at home would have many experiments to make and difficulties to overcome before arriving at a really satisfactory performance. On the other hand a compromise is possible by purchasing the complete mechanical unit, and building only the amplifier, its associated oscillator and a level indicator. For amateurs without a well-equipped workshop this course is strongly recommended.

(To be continued. Part 2 will discuss the design and include a recommended circuit for the amplifier, oscillator and level indicator.)

Cushion that Switch-on Surge in AC/DC receivers

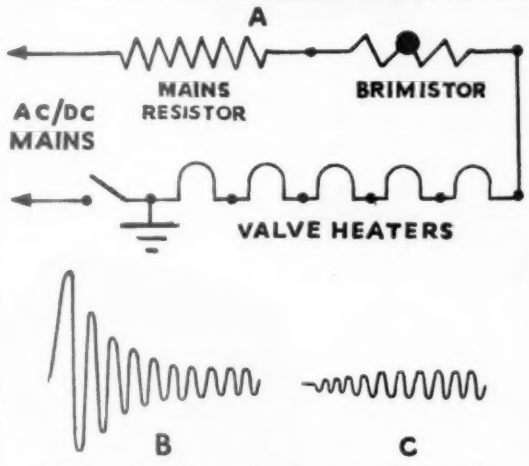


Diagram "A" shows the correct positioning of a Brimistor in the average circuit.

Diagram "B" shows an oscillogram of the normal "switch-on" surge which damages valves and dial lights.

Diagram "C": this oscillogram shows the gentle rise of BRIMISTOR controlled current and complete surge suppression.

OTHER USES

1. Wired in series with the lead to the reservoir condenser, Brimistors can be used to reduce the voltage surge associated with directly heated rectifiers.
2. Connected in series with a choke or focus coil, the negative temperature co-efficient of a Brimistor may be used to compensate for the positive temperature co-efficient of the coil.

CURRENT SURGE
BRIMISTOR
RESISTORS

Wired in series with valve heaters . . . dial lights . . . BRIMISTORS hold the starting current at a low value, permitting it gradually to rise until working temperature is reached, thus ensuring maximum life for both valves and lamps.
When cold the resistance of a BRIMISTOR is high. As it warms up with the passage of current, however, this resistance falls *gradually* to a very low level which usually can be ignored. At the very most a small reduction in the line cord or other voltage dropping resistance will provide the necessary compensation.

CHARACTERISTICS OF BRIMISTORS

Type	Cold resistance at 20° C.	Resistance with the following currents flowing				Max. Current	Price List
		0.1 amp.	0.15 amp.	0.2 amp.	0.3 amp.		
	ohms	ohms	ohms	ohms	ohms	amp.	
CZ1	3,000	180	100	75	44	0.3	*3/6d
CZ2	5,500	170	90	66	38	0.3	*3/6d
CZ3	1,500	100	50	35	—	0.2	*1/6d
C4	760	—	—	—	—	1.25	*5/–d
CZ6	3,000	200	120	80	45	0.45	*3/6d

* Brimistors are not subject to Purchase Tax.

Use CZ1 for 0.3 amp. and 0.1 amp. valves.

Use CZ2 for 0.15 amp. and 0.2 amp. valves.

Wire type CZ3 across the dial lamp (in conjunction with a CZ1 or CZ2 as above).

Notes on the use of BRIMISTORS

1. Owing to the high operating temperature (up to 250° C.) Brimistors must be spaced away from coils and waxed components.
2. They should be inserted in the "live" end of the heater chain—i.e. between mains resistance and rectifier valve heater.
3. At least ½in. of wire must be left at each end before soldering to a tag.

BRIMISTORS are used in all popular AC/DC Television Receivers—ADD SOME TO YOUR STOCK

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makers of BRIMAR VALVES *and* BRIMAR TELETUBES

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balanced, distortion-free reproduction

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extremely kind to records

The G.P.30 crystal turnover pick-up is intended to provide the largest number of record enthusiasts with the best possible reproduction of standard and microgroove records when used in conjunction with commercial equipment such as the normal radio set. The output characteristics give balanced distortion-free reproduction with minimum surface noise. And the use of this Pick-up ensures long record life ; the careful design gives exceptional tracking capabilities at the low stylus pressure of ten grammes.

the Acos GP30

turnover crystal pick-up

Price in Great Britain **£2.10.0**

plus P.T. 21/5.

always well ahead

COSMOCORD LIMITED ENFIELD MIDDLESEX

New High-Grade Condenser Microphones

(*Concluded from p. 54 of the previous issue*)

2.—Details of Neumann Types M50 and U47 and Associated Power Supply Units

By F. W. O. BAUCH

As was described in the previous issue, the new pressure-gradient condenser microphone (Neumann, Type M49) makes use of the combination of two equal cardioid condenser systems mounted back to back, i.e., with their maximum sensitivity in opposite directions. The addition of their output voltages gives the resulting voltage as

$$e = e_1(1+\cos\alpha)+e_2(1-\cos\alpha)$$

which can be expressed as

$$e = (e_1+e_2)\cdot\left[1+\frac{e_1-e_2}{e_1+e_2}\cdot\cos\alpha\right]$$

The form of the characteristic, therefore, depends on the ratio of the difference to the sum of the output voltages of both microphone systems. A flat frequency response of the combination necessitates a flat response of the single microphones.[4]

New Pressure-type Condenser Microphone. The Neumann Type M50 microphone is deliberately built in such a way that the response at high frequencies becomes slightly directional with a slight increase of output. This effect can be observed on its polar diagram (Fig. 15) and its frequency response curve (Fig. 16). In a diffused field of sound the frequency response of the microphone is practically flat.

Fig. 17 shows the interior of the M50 microphone after the protecting cover, which consists of a triple layer of different metal gauzes, has been removed. A flexibly mounted Perspex sphere with a diameter of 40 mm carries, flush-fitting on one side, the actual condenser capsule with the highly stretched diaphragm of an effective diameter of 12 mm. The size of the Perspex sphere was chosen for the above mentioned increase of frequency response to a plane wave front, starting at about 1,000 c/s. The diameter of the

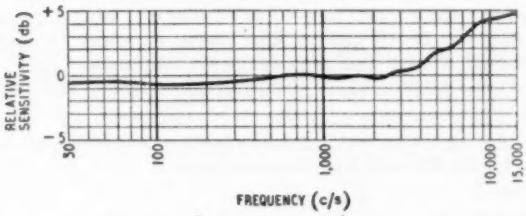
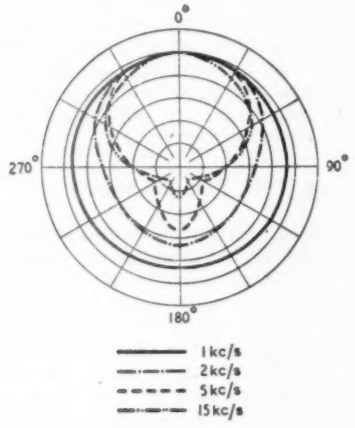
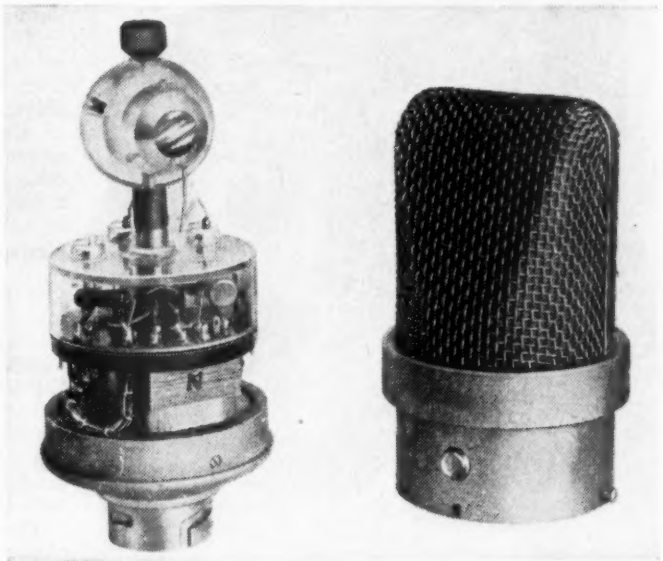


Fig. 16. Frequency response curve of Neumann Type M50 microphone.

Fig. 17. Neumann Type M50 microphone with cover removed.

Fig. 15. Polar diagram of Neumann Type M50 pressure microphone.





[4] H. Grosskopf, *Techn. Hausmitt. des NWDR*, Vol. 4 (1952), p. 209.

diaphragm is sufficiently small compared with the sphere diameter to maintain a favourably broad directional characteristic of the microphone at high frequencies. The capacitance of the capsule, however, must not be too small with respect to the detrimental input capacitance of the amplifier. A sufficiently large capacitance can be produced by an extremely small distance between the diaphragm and the fixed electrode, this distance being here 10μ (1μ= 1/1000 mm). Again, the diaphragm is made from an insulating foil (Polystyrol) of a thickness of 12μ, sputtered with a pure gold layer on one side. These insulating foils are used with much advantage, as they simplify the construction of the capsule and give protection against accidental short circuits between the metallic side of the diaphragm and the fixed electrode. The extremely small mass of such foils, if compared with that of pure metal diaphragms, permits the application of relatively small polarizing voltages to obtain a sufficiently large electrical output.

As stated before, the diaphragm of the M50 capsule is highly stretched, but its resonance of approximately 15 kc/s is mainly determined by the stiffness of the air cushion behind the diaphragm. Suitable cavities in the surface of the fixed electrode are designed for an aperiodical damping of the diaphragm, thus making the transformation of mechanical into electrical oscillations independent of frequency below the resonance of the diaphragm.

The frequency response of the M50 microphone covers the range from 40 to 15,000 c/s, with a gradual increase of up to +5db when exposed to direct sound. Other data are: sensitivity, approx. 0.7mV/μb; overall noise, $<2\mu$V; output impedance, 200 ohms.

Fig. 18. Type N48 a.c. mains operated power supply unit for the M49 and M50 microphones.

The physical dimensions (also those of the M49) are: overall height, 163 mm; greatest diameter, 80 mm; weight, 800 gm. The built-in amplifier is principally the same as that used for the M49 microphone, and is housed below a similar detachable Perspex cover which carries on its top the actual microphone. The output transformer is mounted further down, and the whole assembly fixed to a soft rubber disc as a protection against mechanical vibrations. The threshold noise generated in microphone plus amplifier is of the order of 18-20 phon which compares with the noise of an empty quiet broadcasting studio.

Power Supply Units for Neumann Type M49 and M50 Microphones.—Fig. 18 shows the portable a.c. mains power unit Type N48. The multiple plug connection in the middle of the front panel serves to connect the microphone via a screened rubber-coated cable which carries the voltage supply to and the signal output voltage from the amplifier, the latter being made available at the 3-pin plug in the left lower corner. All plug connections are of the novel and most reliable self-cleaning "Tuchel" type, the counterpart of the multiple socket being shown on the left. On the right-hand side are a handy cable clamp and, above, three terminals, provided for test or measuring purposes, which are connected in parallel with the signal-output plug. The potentiometer for the adjustment of the directional characteristics on the M49 microphone is situated on the upper part of the panel. In the photograph it is set to a position half way between omni-directional (circle) and cardioid. The back panel contains the mains input, mains switch, signal lamp and fuses. The electrical layout incorporates two rectifier circuits for the provision of all necessary voltages and currents for the amplifier, including the polarizing voltages for the condenser capsule.

A second mains power unit, Type N49, incorporating the same circuit diagram, is provided in panel construction for rack mounting. For outside broadcasts, or where there is no mains supply available a portable unit, Type B9, enables the microphones to be operated from internal batteries.

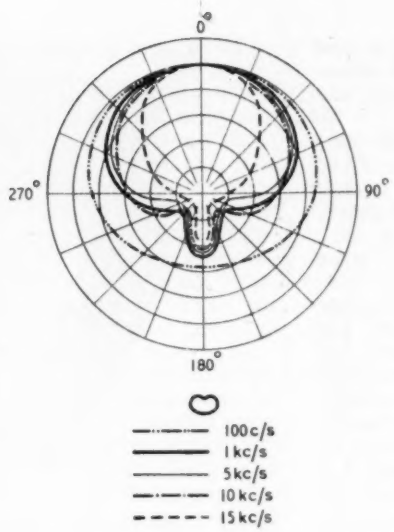
These three units also serve the M50 microphone, in which case the adjustable polarizing voltage is automatically out of action.

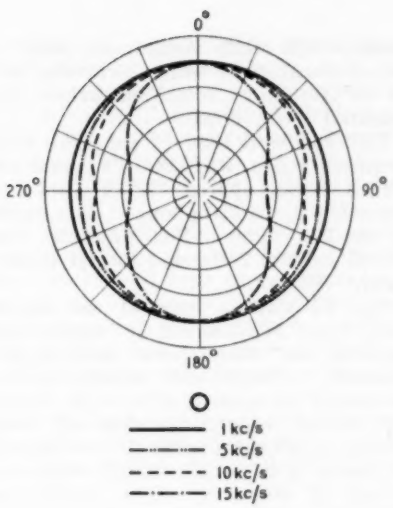
The standard length of the screened multiple cable between microphone and power supply is 10m or roughly 33 ft. Experience showed that this length can, if necessary, be increased to a maximum of about 100 ft, without any changes in frequency response. With the higher ohmic resistance of the cable, however, heater current adjustment must be made inside the power supply units.

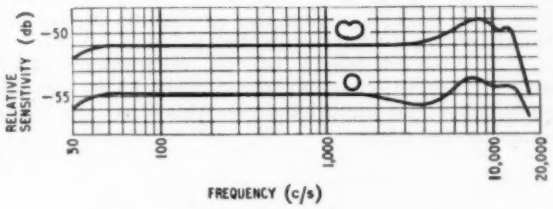
Neumann Type U47 Microphone

A less costly layout of a pressure-gradient condenser microphone of very high performance, incorporating a choice of two fixed directional characteristics (cardioid or omni-directional), is the Neumann Type U47 with its own mains supply unit and microphone cable, the latter fitted with a device for tilting the microphone to any desired angle. Both characteristics can conveniently be selected on the front of the microphone by means of a to-and-fro switch with indicator for the chosen position.

The exterior of the Neumann Type U47 microphone is shown in Fig. 19. The upper part of the







Left: Fig. 19. Neumann Type U47 microphone. Above: Fig. 20. Alternative polar diagrams available in the Neumann Type U47 microphone. Right: Fig. 21. Frequency response curves of the Type U47 microphone.

microphone consists of three protective layers of different wire mesh, and houses the condenser capsule as well as the switch for changing its directional characteristic, the setting of which can be observed in an oval Perspex window inside the metal belt of the cover. In the photograph the microphone is switched to the cardioid position.

The condenser capsule of the U47 microphone is identical with the capsule of the M49, and consists of a perforated fixed middle electrode with two equal diaphragms on either side. One diaphragm is permanently connected to a polarizing voltage. If an omni-directional characteristic is required, the other diaphragm receives the same voltage, which is also of the same direction, via the above mentioned switch. For the cardioid, the switch disconnects the polarizing voltage from the second diaphragm and connects it to zero potential.

The principle of operation is similar to that of the M49 capsule, with the difference that here two characteristics may be chosen and that these are obtained by means of a clear switching-over from one form to the other. The available polar diagrams can be seen in Fig. 20; the respective frequency response curves are shown in Fig. 21.

Fig. 22 gives a picture of the U47 microphone as opened for servicing. The top part with the capsule and the switch is a complete unit by itself, connected to the amplifier assembly on the right by way of a special "Tuchel" 2-pin plug. The valve chosen for the single-stage amplifier is the Telefunken Type VF14, an indirectly heated steel-envelope valve with a 55-V heater. This valve is suspended on soft rubber tapes, upside down, and surrounded by a sponge-rubber ring to intercept any possible micro-

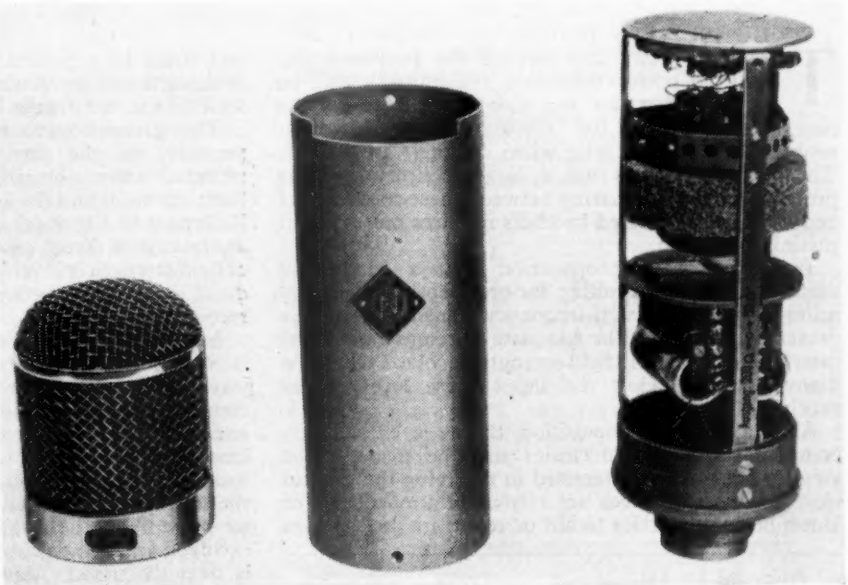


Fig. 22. Type U47 microphone partially dismantled with the amplifier unit on the right.

phony. All other component parts including the output transformer with a switching device for either 50 or 200 ohms matching output impedance, are mounted lower down.

The electrical data of the U47 microphone are: frequency range, 40-15,000 c/s; sensitivity, 2.5mV/μb; overall noise, approx. 1.5μV (<18 phon); overall distortion up to 120 phon, <1%; output impedance, 50 or 200 ohms. The physical dimensions are: overall height, 240 mm; largest diameter, 63 mm; weight 700 gm.

Fig. 23 gives a view of the a.c. mains supply unit, Type NG, which is surprisingly small, yet supplies the microphone and amplifier with all necessary voltages and currents from one bridge-connected selenium rectifier with smoothing circuits. The heater supply branches off from the anode voltage supply, bringing the overall d.c. current of the mains unit to only 40mA, with a maximum d.c. voltage of 100 volts. The overall dimensions are 220×100×120mm. The microphone cable input and the signal output are situated on the front panel. The back panel contains the a.c. mains input, the mains switch, a signal lamp, and a fuse.

The standard length of the microphone cable with "Tuchel" plug fittings is again 33 ft, but the permissible maximum length in this case can be as much as 200 ft.

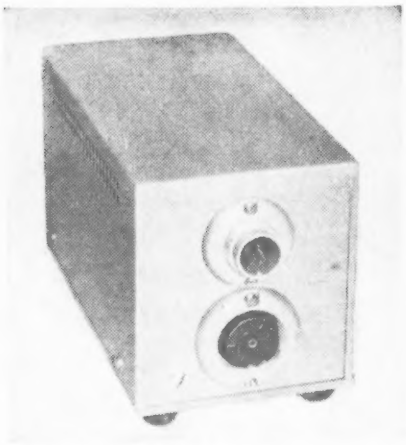


Fig. 23. Type NG mains supply unit for the U47 microphone.

Acknowledgment—I would like to take the opportunity to convey my thanks to Georg Neumann GmbH, Berlin and to the Nordwestdeutsche Rundfunk, Hamburg, for placing comprehensive data at my disposal.

Shared Television Channels

How Horizontal Polarization at One Station May Limit Mutual Interference

By F. R. W. STRATFORD,* M.I.E.E., S.M.I.R.E.

THE good news that two of the proposed five medium-power television transmitters will be in operation for the Coronation provides a timely opportunity for discussing the reception problems which may arise when channels are shared. The British Isles is not a large territory and the problem of channel sharing between these transmitters and their high-powered brothers requires most careful planning.

If normal wave propagation over a conductive surface was the controlling factor a separation of 200 miles between common-frequency transmitters of the present power would be adequate in removing mutual interference since the field strength involved would be many decibels below the input noise level of the receiver.

Although wave propagation theory is exceedingly complex some generalizations may be made. The viewer is essentially interested in receiving the ground wave. This wave does not rely upon atmospheric or ionospheric properties to aid or retard its propagation and could be regarded as the "in-vacuo" wave. It is this ground wave which provides the steady signal well within the fringe limits of reception.

The ground wave may be split into two components, (a) the direct wave and (b) the ground reflected wave. Usually the viewer receives a combination of (a) and (b) and rarely the direct wave only. Reference to Fig. 1 (a) and (b) should make this clear. In the case of direct wave reception the signal intensity of field strength is inversely proportional to the distance d, of separation between the transmitter and the receiver.

In the more usual case, where the received signal is a combination of the direct and ground-reflected wave, it can be proved that the resultant signal is considerably weaker, due to partial phase cancellation and in practical terms the field strength is no longer inversely proportional to d but to d^2. Hence, for the usual mode of reception, doubling the distance reduces the signal strength by a factor of four. It is important to remember these generalized facts as they are involved when the problem of anomalous propagation is next discussed. Apart from the normal mode of

* Belling and Lee Ltd.

propagation anomalous effects may be introduced by the ionosphere or the troposphere.

The ionosphere is that part of the upper atmosphere which is capable of becoming partially electrically conductive due to ionization, and lies between about 50 and 400 kilometres above the earth's surface. The reflecting properties of the ionosphere are essential for world-wide shortwave communications, but it is indeed fortunate that these properties almost completely disappear at television and higher frequencies. Very rarely a set of favourable conditions arise when television signals may be propagated across the Atlantic, and a case is on record of the reception of Alexandra Palace in Johannesburg.

We can therefore neglect ionospheric reflections in dealing with the problems of channel sharing for television and pay attention to a newer phenomenon, namely, tropospheric propagation. The troposphere is that part of the earth's atmosphere extending up to about 10 kilometres. It does not become ionized to an extent sufficient to reflect radio waves, but can bend them by refraction just as light is bent when it passes through a medium of varying refractive index.

Dielectric constant, or permittivity, may be likened to the refractive index in optics. A radio wave propagated in a horizontal direction through a medium in which the dielectric constant varies along the vertical section will be refracted as depicted in Fig. 2(a). It will be seen that a skyward bound wave can only be refracted earthwards when the dielectric constant, K, of the atmosphere is decreasing with height and this is the condition which can give rise to tropospheric propagation.

An extreme condition in which there is a sudden drop in K in the upper troposphere can give rise to reflections which may be regarded as a special case of super-refraction, Fig. 2(b). Propagation under these conditions is often referred to as " ducting."

(*c.f.*—The dielectric constant of air is only minutely greater than unity. At zero centigrade temperature, and normal atmospheric pressure, it is 1.00059 and is slightly dependent on temperature, T, atmospheric pressure P, and partial pressure of water vapour E).

A close approximation to the dielectric constant of humid air is given by the expression

$$K = 1 + \frac{160}{T}\left[P + \frac{4800E}{T}\right] \times 10^{-6}$$

From this it can be seen that K will be decreased and cause earthwards refraction, or reflection, when the temperature increases, or the barometric pressure decreases, with increasing height. In the normal atmosphere the pressure and temperature both *decrease* with height and largely cancel their mutual effect upon the value for K, hence, insignificant refraction takes place and propagation is of the normal ground wave type.

Certain atmospheric conditions however can lead to an increase of temperature, or a rapid drop in humidity (or both), with height. When this occurs super-refraction sets in and some of the upwardly directed energy from the transmitter is returned to earth as indicated by a marked extension of the usual ground wave range. The best meteorological conditions for such propagation may be stated as warm, foggy, and anticyclonic conditions which are more common in summer than in winter. The subject is well treated by Heightman[1] for those who wish to extend their studies of tropospheric propagation.

The important point to remember is that the transmitted wave energy returned to the receiving site due to super-refraction is governed by the inverse d law and not d^2 so that it does not attenuate so severely as the ground-wave. This accounts for the much greater distances achieved when the " freak " conditions are present.

Thus, with the present television powers, it seems essential that the spacing of the shared-channel transmitters must be at least four times the normal steady signal range, but other facts, geographical and technical, may not permit of this separation. Belfast will share frequencies with Alexandra Palace, a distance of 320 miles and Newcastle with Wenvoe, a distance of 250 miles.

It is hoped that such separation is unlikely to produce any serious mutual interference which, in the event of it arising, will be worse at receiving points lying

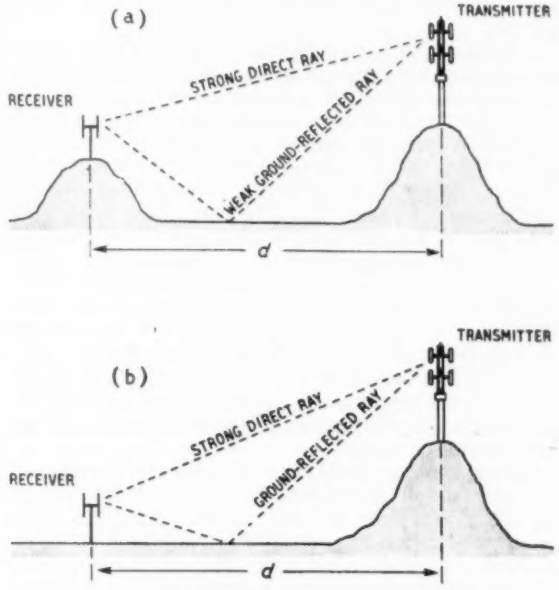
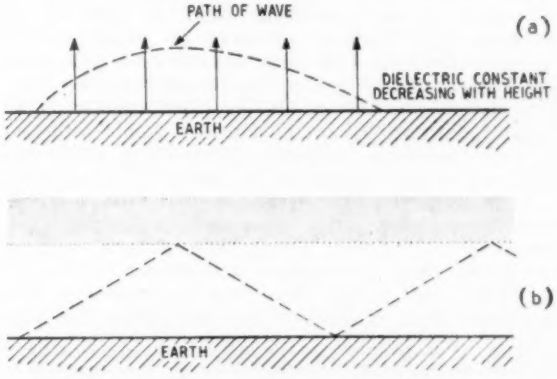


Fig. 1. Received signals consisting of ground-reflected and direct rays, (a) unusual condition with weak ground reflections and (b) more usual with strong ground reflections.

Fig. 2. Troposphere propagation conditions for abnormally long-distance v.h.f. transmission (a) due to a negative dielectric constant gradient and (b) to a sudden drop in dielectric constant in the upper troposphere.



[1] D. W. Heightman. "Propagation of Metric Waves Beyond Optical Range." *Journal Brit. I.R.E.* Vol. 10 No. 10 1950, p. 295.

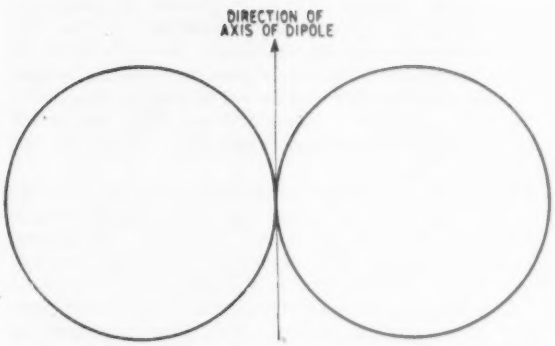


Fig. 3. Directional response of a simple horizontal half-wave dipole.

between the two transmitters. This is important because a directional receiving aerial, possessing a good front-to-back discrimination will be most helpful.

A further degree of freedom from mutual interference may be obtained by the simple expedient of changing the plane of polarization of the radiation field from one of the transmitters. It has been ascertained that the plane of polarization of waves which have been super-refracted, is not seriously affected. Were it, for example, converted to circular polarization by these effects, a vertical or horizontal aerial would respond equally well and nothing would be gained by the expedient.

Theoretically a horizontal receiving dipole should be incapable of receiving a vertically polarized wave, since no e.m.f. would be induced in it. In practise there is from 10 to 20 decibels discrimination only. This is due to the scattering effect of reflecting objects such as trees and buildings, which can account for many angles of polarization for the final waves exciting the receiving aerial.

Nevertheless an additional 10 decibels discrimination will be valuable during "freak" conditions and the B.B.C. are fully justified in deciding upon horizontal polarization for Belfast and Newcastle on these grounds. Because horizontal receiving aerials must be used the advantages and disadvantages of so doing must be discussed.

There are certain attractive advantages to be gained. In the first place a simple vertical dipole is omni-directional, but when horizontally disposed it possesses directional characteristics resulting in a figure-of-eight response, the two zeros occuring in the direction of each tip of the dipole (Fig. 3).

This feature can assist in removing troublesome reflections (ghosts) emanating from the sides of the receiving site without recourse to multi-element arrays. Generally, the more troublesome reflections are from obstacles at the rear of the receiving site. The author has discussed this previously at some length,[2] and in these circumstances a dipole with two or more parasitic elements disposed as reflectors, directors, or combinations of the two, will be required.

It is important to recognize that, for a given number and disposition of parasitic elements, the horizontally disposed array will possess greater directivity than its vertical counterpart. This is obviously due to the minimum responses in the directions along the axis of the horizontal elements. The foregoing is only true when the elements are parallel with one another. Any deviation in the form of a V or X arrangement of elements will vitiate this statement. Thus the simple "H" or "yagi" type of array is likely to prove a better "deghoster" when horizontally disposed. Also the amplitude of discrete ghosts is likely to be diminished since the majority do arise from tall (vertical) structures.

It is also known that ignition interference is predominantly vertically polarized. Some measurements[3] made at a fairly open site near the Great Cambridge Road suggested that a reduction of some 10 decibels may be obtained by the use of a horizontal receiving aerial. Finally, the downlead or feeder from the aerial does not lie in the plane of the elements and thereby modify its intrinsic electrical properties. At the same time this symmetrical form of feeding will reduce the amount of electrical interference which may be induced in the aerial elements due, (a) to out of balance effects in the feeder, and (b) to tighter electrical coupling between the feeder and the aerial.

Turning to the disadvantages. The conventional television aerial elements are generally constructed from tubes of light alloy, and the wall thickness is calculated on the basis of wind forces up to hurricane strength plus a safety margin. The elements of an aerial so designed tend to sag due to gravity when horizontally disposed. Perching crows will also increase this tendency and some permanent "set" may result. It is therefore necessary to increase the wall thickness of the elements with subsequent increase in cost.

The second disadvantage is a considerable increase in picture brightness flutter due to reflections from passing aircraft. It is well established that such reflections are from 6 to 12 db stronger when received by a horizontal aerial, so that viewers on a busy aircraft route may suffer a certain amount of inconvenience in this respect.

The best way of summarizing the subject is to recapitulate by tabulating the advantages and disadvantages of employing horizontal polarization for one station sharing a transmitting channel with another at a reasonable distance.

Advantages	Disadvantages
Greater immunity from mutual interference during conditions of anomalous propagation.	Slightly increased cost.
Improved directional response of simple receiving aerials.	Greater liability to picture flutter due to aircraft.
Greater freedom from interference.	
Probable greater freedom from ghosts.	

It is not always wise to be prophetic in the optimistic sense but the writer is firmly convinced that the choice is wise and that the gains will more than outweigh the losses and that it is extremely unlikely that any unrevealed snags will arise in practice.

[2] F. R. W. Strafford "Receiving Aerials for British Television." Paper No. 1287R I.E.E. Television Convention. April-May 1952

[3] F. R. W. Strafford "Experiments with Television Aerials." *Wireless World*. Vol. 39. 1936, p. 394.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Recording of Broadcasts

MAY I be allowed to comment on the leading article of your January issue?

Copyright has been based for a very long time on the right of an author, artist or composer to prevent another person from copying an original work, such as a book, a tune, or a picture which he has created. More recently this concept has been extended, and now gramophone records enjoy copyright protection. Copyright extends to the performance in public of protected works such as plays, music and records. The recommendations of the Copyright Committee to which you referred are that these rights be perpetuated, and I assume that all your readers will be in general agreement with this; neither the Editor, nor contributors to *Wireless World* would like to see their articles reprinted freely in other journals without acknowledgment or remuneration. The use of tape recorders and the like to record in the home the output of a radio set seems such a glaring example of copying of the work being broadcast from the radio station that one can think of no legal ground on which to defend it if the broadcast material is *itself in copyright*, such as a modern play, a musical composition, a lecture, or a gramophone record. If the home recordist has not obtained permission from the owner of the copyright he will be offending the law as it has been known for many years.

So much for the act of making a copy of a work in copyright.

The Committee has suggested (in para. 117) that a right be given to a broadcasting authority "to control any subsequent copying of its programmes by any means" and this would "extend to prevent the mechanical recording of a broadcast of material which is non-copyright"—as well as of copyright material. If this recommendation becomes law then the recording on a tape recorder of a work out of copyright would be illegal.

Now Section 2 of the Act of 1911 deals with "Fair Dealing" in which it is declared that fair dealing with any work for the purpose of private study, research, criticism, etc., shall not constitute an infringement of copyright—and no change to this has been suggested by the Committee. This apparently means (and I say apparently, because although I was a member of the Committee I am not a lawyer and cannot write authoritatively) that if you record at home for the purpose of private study or criticism such recording could be regarded as fair dealing. But the greatest care must be exercised in interpreting the word "private"; what constitutes "public" is referred to at length in para. 125 of the Report: "it seems to us wise to assume that unless a performance takes place in a *purely domestic* setting the probability is that it will be regarded by the courts as taking place in public." Certainly local radio societies, music clubs and the like are almost certain to be regarded as "public" so that the playing of a tape recording of the broadcast of a copyright work before such a society or club would be outside the domestic circle.

I have thought a great deal about this subject and cannot see that any other ruling would be fair to authors, composers, lecturers, etc.; what an Englishman does in his home is in his castle, provided the walls are thick enough and that there are no strangers within the gate.

Newbury, Berks. T. E. ALLIBONE.

Alternative Television Service

MAY I reply to the leading article in your February issue under the above title? Although I find myself in general agreement with your conclusions about the advisability of temporarily leasing B.B.C. transmitters, I think you paint too gloomy a picture of the difficulties and delays to be overcome before an alternative TV programme can be provided.

It was made clear in the B.B.C. debate that it was *not* necessary for the B.B.C. to complete their TV plans. The Assistant Postmaster-General, in winding up the debate on June 11th, 1952, said:

> The Government are in earnest, not only over breaking the B.B.C. monopoly, but also in permitting sponsored television. They have decided that the B.B.C. shall be allowed to have priority over the completion of the [construction] programme that was held up because of the capital cuts. That does not mean that when adequate resources of money and materials are available competitive TV must wait until the B.B.C. extension is complete in all respects. It does not mean that the B.B.C. will have to put the last coat of varnish on any building that can be put up before competitive TV can be started.

These words, obviously carefully chosen, were spoken in the last speech before the vote was taken and it was on these words that many of us were able to support the Government. You will notice that there is no reference to a need for further progress on v.h.f.

Your leader stated "the Television Advisory Committee is also charged with the task of advising him [the Postmaster-General] on the conditions for competitive television." As I understand it, there may be some duplication of functions between the T.A.C. and the new "controlling body" mentioned in the White Paper Cmd. 8550. The White Paper says in para. 9: "A controlling body will be required . . . for regulating the conduct of the new stations, for exercising a general oversight of the programmes and for advising on appropriate matters; licences for any new stations would be granted (and if necessary withdrawn) by the Postmaster-General on the advice of this body."

Although there are difficulties to be overcome, I don't think, from the above facts, that these are as formidable as you suggest. However, I do welcome your support for the leasing of the B.B.C. transmitters to get the experiment started and at the same time increase the B.B.C.'s income. In a letter published by the *Observer* on September 18th, 1949, I ventured to suggest:

> If in the early years only one TV station is transmitting in an area, we can still have the benefit of competition by dividing the TV hours so that both commercial and national programme sources alternatively feed the same transmitter.

This might provide a temporary expedient, but I hope that it would not delay other people proceeding with their plans to construct their own transmitting facilities, so that the public may not be denied the right of looking at any alternative programme should they so desire.

House of Commons. C. I. ORR-EWING.

Television Modulation

THE letters from F. C. McLean and E. Green in your February issue discuss the conversion efficiency of the low-level modulation television transmitters now operating at Kirk o' Shotts and Wenvoe. Your correspondents are correct in stating that under peak-white conditions the efficiency of the newer stations is greater than that of Sutton Coldfield or Holme Moss, where high-level modulation is used, but we would stress that this efficiency advantage is maintained at all depths of modulation, and in fact becomes even greater at small modulations corresponding to the average picture. In the older transmitters it is only the final stage that takes a reduced power as the modulation decreases; the power input to the rest of the transmitter remains constant. If low-level modulation is employed, a greater number of stages can be of the variable power input type and two such stages are included at Kirk o' Shotts and Wenvoe, so that there

is a larger reduction in power drawn from the mains as the white-content of the picture falls.

We agree with your correspondents that conversion efficiency is only one criterion of many which must be considered in design; another on which both have commented is the relative floor-area occupied by the two types of transmitter. The newer transmitters also contain the low-tension switchgear which accounts for 40 per cent of the floor area of the Holme Moss transmitter and yet they are smaller by some 100 square feet. We submit that by this reduction in size and the improvement in efficiency a significant step towards overall economy of the service has been taken.

Hayes, Middlesex. E. McP. LEYTON.
E. A. NIND.

Psycho-Optics in Television

IT is with great interest that I read the article by C. Burns in the January *Wireless World*. I should like to point out that in your February, 1946, number you published a short article of mine entitled "Television Psychology: Is the Large Screen Essential?" which was partly based on the same suppositions and came to the same conclusions as Mr. Burns' contribution.

Berne, Switzerland. PAUL BELLAC.

IN the article in your January issue the author attempts to explain why a large television screen is "better" than a smaller one, basing his argument on the fact that binocular vision enables the viewer to distinguish between a small screen close by and a large screen further away, whereupon if both appear sharp "the deduction is unconsciously made that the larger picture contains more detail than the smaller."

We are offered no corroborative evidence of this latter statement, which I find a trifle ingenuous. Even if it can be proved to be true, it does not logically follow that the author has proved his point. For example, many painters and photographers depend for their effects largely upon sheer size, with no attempt to secure fine detail or even to imply it; in fact such pictures would actually lose in impressiveness if cluttered with detail.

I suggest that the true answer is more subtle than your author supposes. Perhaps other readers may have alternative theories.

Iver, Bucks. L. S. LEPAGE.

Phase-Angle Ellipse

HAVING read the note in the October issue on the measurement of phase angle, I feel that it may be of interest to give a more general solution which is even less well known. This solution does not require that both deflections should be of the same amplitude.

If the x-deflection is of amplitude E_x and the y-deflection of amplitude E_y and the phase angle between them is θ, it can be shown that

$$\theta = \sin^{-1}\frac{CD}{E_xE_y}$$

where C and D are respectively the major and minor axes of the ellipse as in the original note referred to above. In words: "The ratio of the product of the major and minor axes to the product of the total x- and y- displacements is equal to the sine of the phase difference of the two signals."

Kingswood Warren, Surrey. G. G. GOURIET.

Signal Tracing

C. H. BROAD'S letter on signal tracing in your January issue is of interest to me since my firm imported the Rider "Chanalyst" Signal Tracer in 1938. Importing ceased on the outbreak of war.

We still have one in our service department which has been switched on all day every working day since 1938, and is still giving excellent service; replacements have been one valve, one coupling condenser and three "magic eyes."

We believe the Rider "Chanalyst" was the first commercial signal tracer to be marketed in this country.

Holiday & Hemmerdinger, Ltd., J. S. HOLIDAY.
Leeds.

Input to Output

READING circuit diagrams from left to right is quite universal in the world of telecommunications. I cannot help feeling that your explanation (p. 21, January issue) is hardly correct and perhaps a little far-fetched.

I have no experience in the Far East, and cannot, therefore, answer for the reactions of Chinese and Japanese engineers. But during my long work with colonial broadcasting operatives in the Middle East, I have never discovered any hesitation on their part to draw or follow diagrams in our style and conception; i.e., beginning with the input on the left and proceeding along the circuitry towards its output on the right of the paper.

And this practice was in no way affected by the fact that the mother tongues of many of my colleagues and staff were being written and read in the oriental style from right to left, as in Arabic, Hebrew and other near-eastern languages.

Great Baddow, Essex. W. G. POWER.

BREAK-THROUGH IN HEARING AIDS

—And a New Use for Crystal Detectors

ACCORDING to a letter published in *The Silent World*, journal of the National Institute for the Deaf, hearing aids may in certain circumstances be affected by break-through of radio signals. The letter reads:—

> One of my colleagues sitting in his South Kensington flat, recently heard a disembodied voice make a number of remarks, among which was a reference to a local road " . . . Harrington Road . . . " For my part, when passing London Airport I have often been disturbed to hear loud "peeps" as though from horns, although no cars have been near. Each of us uses a valve amplifier hearing aid continuously, and the explanations appear to lie in the interception of short-wave radio communications by taxicab fleets and in the interception of airport radar scanning beams. I am able to detect the passage of a rotating radar beam at a distance of 200 yards, and when close up to the reflector, the signal is so strong that a companion can hear the periodic "peeps" coming from my fitted earpiece. Hearing aid manufacturers will need to fit r.f. stoppers in future designs!
>
> Many years ago when trying a pick-up coil in conjunction with a home-made hearing aid for telephone conversations, I received high-quality reproductions of our golden voiced TIM and the two B.B.C. programmes, simultaneously. This prompts me to add that there is undoubtedly a market for plug-in units for our hearing aids, containing simply a tuning system and a modern crystal detector so that we may hear the radio programmes wherever we are. What fun it will be to switch over to "Twenty Questions" when the speakers at our business meetings are unexpectedly dull. *Again* we will have the advantage of our hearing friends. Already we can switch off, but the future offers us stand-by entertainment as well!
>
> Twickenham. F. W. CUCKOW.

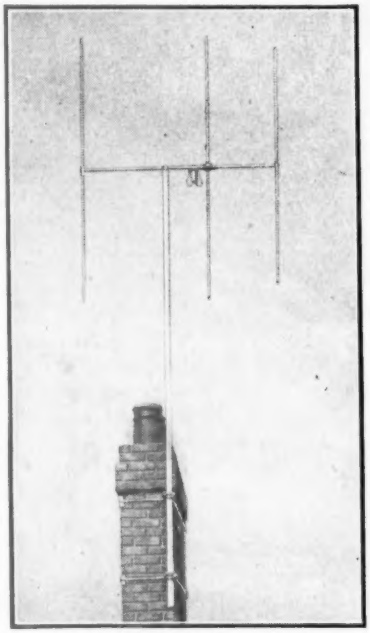
Mr. Cuckow tells *Wireless World* that, since his letter was written, he has made a broadcast receiver unit for use with his hearing aid. The design of the radio unit closely follows that of the receiver employing a G.E.C. germanium diode described in our September, 1951, issue. Apparently a "random" aerial gives sufficient signal pick-up in the London area, and the 2-circuit tuner of the unit gives enough selectivity.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference.

Your T.V. Aerial ! When did you last examine it ?

A letter came in the other day asking for reprints of this page. By way of comment the writer told us that he still has his original "Belling-Lee" T.V. aerial that was erected on October 29th 1938—fourteen years in all weathers and without attention. That is the kind of letter we like to receive. However, we will continue to ask users to take advantage of the protective nature of paint. The cost of an aerial spread over a number of years is not much, but it is a nuisance having to cope with



"Belling-Lee" 3-element array.

replacements which generally become necessary at the most inconvenient times. Just think, if your aerial failed on the morning of the Coronation, and you were so located that a good aerial really was necessary. Don't take chances, put up a "Belling-Lee" aerial in the first place, or if you have been disappointed, in the second place ; treat it well, treat it to a coat of paint.

Reception in Norfolk

We know of receptions near Dersingham, and supposed most people round this area would look in on Sutton Coldfield, 96 miles away. However, the aerial we are thinking of looks at Holme Moss 108 miles away. It is a "Belling-Lee" "Junior Multirod" with a mast head pre-amplifier, and results are excellent. Of course the Holme Moss mast is very high and there is low ground for about 80 miles to the north west. The nearest transmitter is not always best.

Mast Head Pre-amplifier Unit.

Wenvoe is on the air with full power

We have a monitoring post at a difficult spot near Andover, where we have a really good aerial. First we tried London, 66 miles distance, on 17 K.w., but results were bad. We then changed to Sutton Coldfield, 96 miles on 50 K.w., results were better, but not what we would call real entertainment value. When Wenvoe came on the air with 5 K.w., 80 miles away, the signal was there, and we tried a mast head pre-amplifier, this produced the best results to date ; then when Wenvoe came on 50 K.w. it was almost too good. This will surely bring tremendous satisfaction to an enormous number of people situated in what has hitherto been considered almost dead ground.

Power Unit.

Channel Conversion and Aerials

Reprinted in its entirety from the "Murphy News", the House Organ of Murphy Radio Limited.

We still come across cases where television receivers have been converted for use on an alternative channel, and results have not been entirely satisfactory because the dealer has not changed the aerial to suit the new transmitter frequency.

In many of these cases the receivers have been working on the fringe of one transmission area, and the conversion brings them into the swamp area of a new transmitter. The first receiver is converted, tried out on the existing aerial and the results are so startlingly good on first tests that the dealer is convinced that all the fuss and bother of converting aerials is unnecessary. Everything goes happily for a week or two. Then it is found that a customer complains of low sound, sound on vision, vision on sound or heterodyne patterns, and by this time the question of aerials has been completely forgotten. So the engineer suspects faulty conversion instructions, outside interference, bad design, or anything but the aerial.

Our worry on this point is not only for the customer who complains ; there must be many set owners who are getting sub-standard results from this cause, but are not complaining, simply because they do not know what the performance should be.

We regard this matter as of some importance and we feel that it is a dealer's duty to the customer, when converting a receiver from one channel to another, to change the aerial at the same time.

An interesting thought for Farmers

If farmers with television would take the trouble to suppress all the motor vehicles on the farm, and encourage their regular visitors to suppress their cars, they would then have a most useful indication as to when a strange vehicle was around, because unfortunately, there are still a far greater number of cars that are unsuppressed than suppressed. At least one poultry thief has been caught in this way.

Written 24th January, 1953

BELLING & LEE LTD
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serve mankind

The jungle is no longer the barrier which for so many centuries hampered the progress of communications. Guglielmo Marconi's invention of wireless overcame this obstacle just as it overcame the ocean and the desert. The Company which he founded is still exploring, in the same exacting way, new ideas and techniques for bringing communications more fully into the service of mankind.

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WORLD OF WIRELESS

24-Hour Standard-Frequency Transmissions • Belfast Television Station • F.M. for Amateurs • Show News

Standard Frequencies

FOR the past three years the G.P.O. Rugby Station (MSF) has been radiating an experimental service of standard frequency transmissions under the auspices of the National Physical Laboratory. These transmissions have been for short periods each day and on different frequencies. We learn that it is now planned to introduce a 24-hour service in the near future. These transmissions, which will still be radiated from Rugby but with a reduced power, will be on several of the six internationally agreed carriers for this service, i.e., 2.5, 5, 10, 15, 20 and 25 Mc/s.

The following 15-minute cycle is at present in use during each transmission period and will probably be repeated throughout the 24 hours:—carrier modulated with 1,000 c/s for five minutes, one cycle-per-second timing pulses for five minutes, the carrier unmodulated for four minutes and the call-sign and announcement for one minute.

Our sister journal, *Wireless Engineer*, publishes each month the results of measurements made daily by the N.P.L. on the standard frequency transmissions from Rugby.

Physical Society's Show

ALL the exhibits at this year's show of scientific instruments and apparatus sponsored by the Physical Society will be housed in one building—the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7.

As already announced, tickets are available from the Society and exhibitors for specific days or morning or evening sessions. The morning of the opening day (April 13th) is reserved for Fellows of the Society and the Press. It will be open daily from 10 a.m. until 8 p.m., except on the last day (April 17th) when it closes at 5 p.m.

The Handbook of the exhibition can be obtained (price 6s or 7s 3d by post) from the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

N. Ireland Television

A SITE has now been acquired about 2½ miles from the centre of Belfast for the installation of the temporary low-powered television station which will serve the city and its immediate surroundings. The station, which will be known as Glencairn, will share Channel 1 (45 Mc/s vision, 41.5 Mc/s sound) with Alexandra Palace. Transmissions will be horizontally polarized.

The permanent stations at both Belfast and Pontop Pike (Newcastle) will, of course, employ asymmetric side-band transmission. The temporary station at Glencairn, however, was originally to use the double side-band system, but it was subsequently decided to adapt both the mobile transmitters for asymmetric side-band operation.

The Glencairn transmitter will differ from all the others in the B.B.C. service in that it will not be possible for it to operate synchronously as the electricity supply in Northern Ireland is not linked with the mainland grid system. To give manufacturers an opportunity of testing sets asynchronously the B.B.C., at the instigation of the British Radio Equipment Manufacturers' Association, unlocked the Alexandra Palace frame frequency from the mains during the daily test period from January 19th to 23rd.

National Show

THE R.I.C. has confirmed the previously announced provisional dates for the 20th National Radio Show. They are September 1st-12th at Earls Court, London.

Admission on the first day of the show will be limited to holders of invitation tickets and dealers' season tickets; the public will not be admitted on this preview day. It will be open daily from 11 a.m.-10 p.m.

Amateur F.M.

WITHIN a few days of the publication of the list of amateur facilities in our January issue (p. 16) the Post Office announced that as from January 31st British amateurs would be permitted to use frequency modulation (F1, F2 and F3) in six more bands: 1715-2000, 3500-3635, 3685-3800, 7000-7300, 14000-14350 and 21000-21450 kc/s.

The notice stipulates that the carrier frequency must be at least 10 kc/s within the limits of the frequency band in use and that the maximum deviation of carrier frequency must not exceed 2.5 kc/s. The maximum effective modulating frequency is limited to 4 kc/s and the a.f. input to the frequency modulator at any frequency higher than 4 kc/s must not be less than 26 db. below the maximum input at lower frequencies.

Higher Technology

IN pursuance of the Government's stated policy of establishing at least one institution of university rank devoted predominantly to the teaching and study of higher technology, it has been decided to develop the Imperial College of Science and Technology (South Kensington). There are at present 1,650 full-time students at the College and it is planned to increase this number to 3,000 during the academic quinquennium 1957-62. This was

THEATRE TELEVISION. Four large screen (4 ft × 3 ft) projectors installed in the Scala Theatre, London, enabled the audience to follow the continuity of the televised stage show and the film sequences inserted at Alexandra Palace. The equipment was installed by Aren.

announced in Parliament on January 29th in response to questions regarding plans for the establishment of a technological university.

T.A.C. Sub-Committee

A TECHNICAL sub-committee of the Television Advisory Committee has been set up under the chairmanship of Dr. W. G. Radley, engineer-in-chief, G.P.O. The other members are: H. Faulkner (G.P.O.); H. Bishop (B.B.C.); R. T. B. Wynn (B.B.C.); P. H. Spagnoletti (B.R.E.M.A.); K. I. Jones (Cossor); B. J. Edwards (Pye); G. M. Wright (Marconi's); Dr. R. L. Smith-Rose (D.S.I.R.) and Professor Willis Jackson (Imperial College).

Radio and the Blind

THE latest radio textbook to be produced in Braille by the National Institute for the Blind is the American "Radio Amateur Handbook." Produced by hand (there will be, therefore, only two copies) the handbook will occupy some 20 volumes.

The N.I.B. Report for 1951-52 records that since the British Wireless for the Blind Fund was started in 1929 nearly 95,000 sets and relay installations have been supplied to blind people in the U.K.

A special research fund has been inaugurated to investigate the various methods of recording in relation to the production of "Talking Books," which at present are recorded on 12in discs at 24 r.p.m.

Indexes

THE index to the 1952 volume of *Wireless World* is now ready and is available from our Publishers, price 1s (postage 2d). Cloth binding cases for the volume are also obtainable, with index, price 6s 5d by post. Our Publishers can also undertake the binding of readers' own issues; the cost including binding case and index being 17s 6d plus 10d postage.

We would also again remind readers of the index to the abstracts and references section of *Wireless Engineer*. This indexes under 18 subject headings some 3,500 articles on radio and allied subjects published in the world's journals during the past year. It is obtainable by post from our Publishers, price 3s 9d.

PERSONALITIES

Professor Willis Jackson, D.Sc., D.Phil., M.I.E.E., who has occupied the Chair of Electrical Engineering at the Imperial College of Science and Technology (London University) since 1946, has accepted the full-time appointment of director of research and education with the Metropolitan-Vickers Electrical Co. The appointment, which is from next July, carries with it a seat on the board of the company. Professor Jackson, who occupied the Chair of Electrotechnics at Manchester University from 1938–46 was previously with Metrovick as a research engineer. He is a member of the N.P.L. Radio Research Board and the T.A.C. technical sub-committee.

(Left) *PROFESSOR WILLIS JACKSON*

(Right) *R. R. C. RANKIN*

Dr. C. Dannatt, O.B.E., M.I.E.E., who, on his appointment as assistant manager of the Metropolitan-Vickers Electrical Co. in 1951 succeeded Sir Arthur Fleming as the company's director of research and education will relinquish this post on Professor Willis Jackson's appointment to devote more time to his managerial duties.

Brigadier J. B. Adams, B.A., A.M.I.E.E., is now head of the Telecommunications Department in the London office of the Iraq Petroleum Co. and associated companies. He previously served for over 25 years in the Royal Signals and on his retirement in May, 1952, was Deputy Director of Signals at the War Office.

Dr. Thomas E. Allibone, F.R.S., director of the A.E.I. Research Laboratory at Aldermaston, has been appointed to the board of the Edison Swan Electric Co., which is a member of the A.E.I. Group of companies, as director of research.

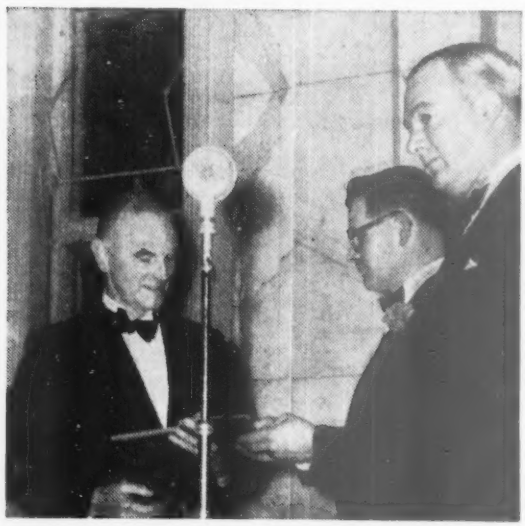
Richard R. C. Rankin, O.B.E., A.M.I.E.E., who a few months ago was appointed technical manager of Mullard, Ltd., and Mullard Equipment, Ltd., and has since become a director of the organization, has also been appointed a director of Telcon Telecommunications, Ltd. (owned jointly by Mullard and the Telegraph Construction and Maintenance Co.). He succeeds Dr. C. F. Bareford who, as announced in our January issue, resigned on his appointment as chief superintendent of the Long Range Weapons Establishment at Woomera, South Australia.

Sidney Webster has been appointed specialist radio representative of the Edison Swan Electric Co., Ltd., in the company's Birmingham District Office. He thus returns to the company he left in 1947 after twenty-two years' service at its valve factory at Brimsdown.

B. C. Fleming-Williams, director of research, A. C. Cossor, Ltd., and **K. E. Harris,** the company's research manager, are visiting subsidiary companies in the U.S.A. and Canada, and during their two-months' tour will investigate current electronic developments in North America.

O. W. Humphreys, director of the Research Laboratories of the General Electric Co., is touring Australia. During his visit he will lecture to a number of engineering societies, including a joint meeting of the Institution of Radio Engineers and the Institution of Production Engineers.

H. D. Wilson, sales engineer for the past 15 years with the Sifam Electrical Instrument Co. has been appointed to the board of directors. Prior to joining Sifam he was with S. G. Brown, Ltd., and Measuring Instruments (Pullin), Ltd.



H. S. MACADIE designer of the well-known Avometer, was presented with a gold wrist-watch on completing 25 years' service with the Automatic Coil Winder and Electrical Equipment Co. Mr. Macadie, who is the Company's chief instrument engineer, is on the left and Mr. J. H. Rawlings, managing director, is on the right.

Sir Stanley Angwin, K.B.E., is to be the thirty-first recipient of the Faraday Medal (awarded annually by the I.E.E.) "for his outstanding contributions to the development of telecommunications in Great Britain and in the international and intercontinental fields." Sir Stanley, who is at present chairman of the Commonwealth Telecommunications Board, was engineer-in-chief of the Post Office from 1939 to 1947 and chairman of Cable and Wireless from 1947 to 1951. Whilst at the Post Office, which he joined in 1906, he played a major part in the design and construction of the Leafield, Cairo and Rugby radio stations.

Sir Harry Railing, D.Eng., chairman and joint-managing director of the General Electric Company, has been elected an Honorary Member of the I.E.E. "for his services to the electrical engineering profession and to the science; and for his services to the Institution."

OUR AUTHORS

J. M. Carter, author of the article on the design of a magnetic recorder, graduated from Durham University in 1941. For the following five years he was engaged on radio valve development. In 1946 he joined the research staff of Wright and Weaire, Ltd., where he has been engaged principally on magnetic recording research and development.

A. Q. Morton, who describes an oscillator/filter unit on page 129 of this issue, was a wartime trainee of our frequent contributor M. G. Scroggie at an R.A.F. Radio School, where he took the radar course. He went on to T.R.E. to work on OBOE. He is now a minister of the Church of Scotland.

OBITUARY

It is with regret we record the death on January 12th of **H. Leslie Dixon,** aged 79, founder in 1919 of Leslie Dixon and Co., who specialize in the disposal of ex-Government radio and electrical apparatus. The company, which also makes, repairs and calibrates measuring instruments, has been under the management of R. H. Hatfield since the retirement of Mr. Dixon in 1950.

IN BRIEF

Receiving Licences.—An increase of 711,632 television licences during 1952 is recorded by the Post Office, making a total of 1,892,832 at the end of December. There were 10,966,641 sound broadcasting licences—including 172,657 for cars—current at the end of the year, making an overall total of 12,859,473—an increase of 311,773 on the previous year.

Electronics in Nucleonics.—A limited number of physicists and electronic engineers holding a degree or equivalent qualification are invited by the Atomic Energy Research Establishment, Harwell, to attend a course on the design, use and maintenance of electronic instruments in nuclear physics. The course, for which the fee is 12 gns, will be held at the Isotope School, Harwell, from March 16th to 20th. Application forms may be obtained from the Electronics Division, A.E.R.E., Harwell, near Didcot, Berks.

H. F. Measurement.—A conference devoted exclusively to the techniques and problems of high-frequency measurement was held in Washington from January 14th to 16th. The four main sessions of the conference, which was sponsored jointly by the American I.E.E., I.R.E. and the National Bureau of Standards, were devoted to (a) frequency and time, (b) transmission and reception, (c) impedance and (d) power. H. J. Finden, M.I.E.E., of the Plessey Co., read a paper on "Developments in Frequency Synthesis" at this convention. It described a method of generating any single frequency out of a possible 100,000 in the spectrum 1kc/s-100Mc/s locked in terms of a frequency standard.

Graduate and Vacation Apprenticeships at the various establishments of the General Electric Co. and the opportunities for training and experience provided by the Company are outlined in the booklet "The Graduate in the G.E.C." which is obtainable from Magnet House, Kingsway, London, W.C.2.

French Components.—The annual exhibition of French radio components, valves and testing gear, sponsored by the Syndicat des Industries de Pièces Détachées et Accessoires Radioelectriques et Electroniques (SIPARE) and other associations is being held in the Palais des Expositions, Porte de Varsailles, Paris XV, from February 27th to March 3rd.

Student Apprenticeships have been introduced by E. K. Cole, Ltd., to provide a more general training than that available under the Company's existing apprenticeship scheme. They are open to present Ekco apprentices of, or over, 18 years of age, and are intended to fit the trainee for an appointment in the engineering works or office.

Institute of Technology, Loughborough College, is the title given to the Engineering and Science Departments of the college, which have been taken over by the Ministry of Education and reorganized as a separate establishment.

Civil Defence Radio.—The first handbook on Civil Defence issued by the Home Office is entitled "Wireless Instructions for Civil Defence" and deals briefly and in simple terms with the setting up of stations and operating procedure. It is obtainable from H.M.S.O. price 6d.

Speed of Radio Waves.—The general assembly of the International Scientific Radio Union (U.R.S.I.) has, as a result of investigations made in recent years by several different methods, recommended that the following value of the velocity of electro-magnetic waves in vacuum be adopted for all scientific work:—299792 ± 2km/sec.

Radio Meteorology.—A four-day conference with sessions on such topics as tropospheric radio propagation and radar storm detection and rainfull determination is joinly planned for next November by a number of scientific bodies in America. Further particulars may be obtained from L. G. Cumming, Technical Secretary, Institute of Radio Engineers, 1, East 79 Street, New York City, who is one of the seven members of the steering committee.

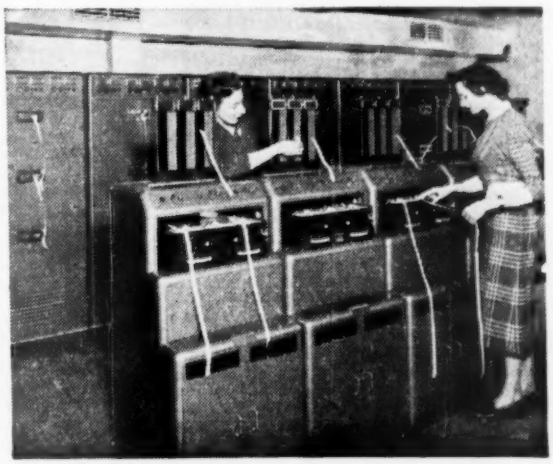
C.C.I.R. London Meeting.—The next plenary assembly of the International Radio Consultative Committee (C.C.I.R.), which is the constituent body of the International Telecommunications Union concerned with the study of technical radio questions, will be held in London in September.

Industrial Training.—A new scheme for the further education of employees who are over the age of entry to the normal apprenticeship and part-time day-release schemes has been introduced by E.M.I. Engineering Development, Ltd., at their factory in Wells, Somerset. The employees have been given the opportunity to increase their technical knowledge and obtain professional qualifications by a self-education home-study course of training under the personal supervision of a qualified tutor who makes regular weekly visits to the works. The scheme is being conducted in co-operation with E.M.I Institutes.

Persian Gulf Communications.—New radio-telephone circuits in the Persian Gulf opened by Cable and Wireless, Ltd., link Bahrein with Muscat and Kuwait, which is also linked with Baghdad by a new W/T circuit.

Receivers for Rhodesia.—Three export broadcast receivers are among the 400 or so exhibits being sent to Bulawayo, Southern Rhodesia, by the British Council for the British Pavilion at the forthcoming Rhodes Centenary Exhibition. They are the Murphy TA192 (4+1-valve 3-waveband a.c. or d.c. superhet), the Pye PE60 (6-valve, 11-waveband a.c. superhet) and the Alba X707 mains-battery portable radiogram.

CONSOLES for the Creed equipment at the new Teleprinting Headquarters of British European Airways in London were supplied by Widney-Dorlec. In the foreground are the two-tier, three-gang transmitters and in the rear the receiving consoles, each accommodating three printing perforators.



Missing Digit.—The price of the console television cabinet Type 21B was erroneously given as £2 17s 6d in the advertisement of the Winter Trading Co. on page 49 of our February issue. It should be £12 17s 6d.

B.S.I. is to move into new headquarters—British Standards House, 2, Park Street, London, W.1—later in the year. This move will bring under one roof the various sections which are now housed in several buildings. The Institution prepares some 250 new and revised British Standards annually and sells nearly a million copies of them. It, incidentally, convenes some 3,800 committee meetings during the course of a year.

School Broadcasting.—New premises have been taken over by the Schools Broadcasting Department of the B.B.C. at 1-1A, Portland Place, opposite Broadcasting House. The new building has five studio suites in addition to offices. Since 1945, school broadcasting has been conducted from Film House, Wardour Street, London, W.1.

R.C.E.E.A.—A new class of membership—associate members—has been introduced by the Radio Communication and Electronic Engineering Association, mainly for manufacturers having a limited interest in the field of radio communication. The member firms constituting the council, re-elected at the annual general meeting on January 23rd, and their representatives are: B.T.H. (V. M. Roberts), E.M.I. (J. S. Carr), G.E.C. (M. M. Macqueen), Kelvin and Hughes (C. G. White), Marconi's (F. S. Mockford), Metrovick (L. H. J. Phillips), Mullard (T. E. Goldup), Murphy (K. S. Davies), Plessey (P. D. Canning), Pye (C. O. Stanley), Redifon (B. St. J. Sadler) and Standard Telephones (L. T. Hinton).

B.R.E.M.A.—The annual general meeting of the British Radio Equipment Manufacturers' Association will be held on March 5th at the Savoy Hotel, London.

INDUSTRIAL NEWS

International Aeradio are to install an air traffic control desk at the Armstrong-Whitworth aerodrome at Bitteswell, near Rugby. The facilities provided will include a four-channel radio-telephone control panel and a remote indicator for the Marconi AD200 direction finder. Radio communication equipment being supplied with the desk includes Pye and Marconi v.h.f. transmitters and receivers.

Relay Companies Combine.—It is announced that plans are being made for the integration of the sound and television relay services of British Relay Wireless, Ltd., and Link Sound and Vision Services, which was formed jointly by Pye, Ltd., and Murphy Radio in 1950. The first television relay system of Link Sound & Vision was installed in Gloucester in 1951.

Ekco's Canadian Distributors.—Canadian Aviation Electronics, Ltd., of Montreal, have been appointed by E. K. Cole, Ltd., exclusive distributors in Canada for Ekco radio, television, communications, radar and nucleonic equipment. Canadian Aviation Electronics will assemble and manufacture Ekco products in Canada.

Mullard.—The commercial activities of the three product groups of Mullard's Equipment Division (radio, telephone and general electronics) are now centred at 6, Gate Street, Lincoln's Inn Fields, London, W.C.2 (Tel.: Chancery 8421), under the recently appointed commercial manager, Capt. R. T. Paul. The general manager, J. P. Jeffcock, and his immediate staff remain at the company's head office, Century House, Shaftesbury Avenue, London, W.C.2, to which address all correspondence should continue to be sent.

MEETINGS

Institution of Electrical Engineers

Discussion on "Is the Presentation of Technical Literature Adequate?" Opener Professor M. G. Say, Ph.D., M.Sc., on March 9th.

Discussion on "Use and Abuse of Research," opener S. Whitehead, Ph.D., M.A. on March 30th.

Radio Section.—"The Study of a Magnetic Inverter for Amplification of Low-Input-Power D.C. Signals" by E. H. Frost-Smith, B.A., Ph.D., on March 3rd. (Joint meeting with Measurements Section).

"Low-Level Modulation Vision Transmitters, with special reference to the Kirk o'Shotts and Wenvoe Stations" by E. McP. Leyton, E. A. Nind, B.Sc. (Eng.), and W. S. Percival, B.Sc. (Eng.), on March 11th.

Debate: "That Broadcasting Hours Should be Drastically Curtailed" on March 23rd.

All the above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

East Midland Centre.—"Some Modern Problems in the Field of Technical Education" by D. S. Anderson, Ph.D., B.Sc., at 6.30 on March 24th at the Gas Dept. Demonstration Theatre, Nottingham.

Cambridge Radio Group.—Paper on "Electronic Equipment in Aircraft" at 8.15 on March 17th at the Cavendish Laboratory, Cambridge.

Mersey and North Wales Centre.—"Radio Telemetering" by E. D. Whitehead, M.B.E., and J. Walsh, B.Sc., at 6.30 on March 16th at the Town Hall, Chester.

North-Eastern Radio Group.—"An Improved Scanning Electron Microscope for Opaque Specimens" by D. McMullan, M.A., at 6.15 on March 2nd at King's College, Newcastle-on-Tyne.

North-Western Radio Group.—"A Method of Designing Transistor Trigger Circuits" by Professor F. C. Williams, O.B.E., D.Sc., D.Phil., F.R.S., and G. B. B. Chaplin, M.Sc., at 6.30 on March 18th at the Engineers' Club, Albert Square, Manchester.

South-East Scotland Sub-Centre.—"Modern Trends in Aerial Design" by J. Patterson at 7 on March 18th at Heriot-Watt College, Edinburgh.

South Midland Radio Group.—"Electronic Motor Control" by S. H. Dale at 6 on March 23rd at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Southern Centre.—"Electronic Telephone Exchanges" by T. H. Flowers, M.B.E., B.Sc., at 6.30 on March 4th at the University, Southampton, and at 7.30 on March 18th at R.A.E. Technical College, Farnborough.

"An Investigation into the Mechanism of Magnetic Tape Recording" by P. E. Axon, O.B.E., M.Sc., Ph.D., at 6.30 on March 18th at the South Dorset Technical College, Weymouth.

London Students' Section.—Visit to the Plessey Co., Ltd., Ilford, Essex (Modern Production Methods for Radio Receivers and Equipment) at 2 on March 11th.

British Institution of Radio Engineers

London Section.—A discussion on "The Standardization of Symbols and the arrangement of Electronic Circuit Diagrams" opener L. H. Bainbridge-Bell, M.A., at 6.30 on March 10th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—"Electronics in Nuclear Research" by J. M. Reid (Glasgow University) at 7 on March 5th at the Lecture Theatre, Natural Philosophy Dept., University of Glasgow.

North-Eastern Section.—"Slotted Aerial Design" at 6 on March 11th at the Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-on-Tyne.

West Midland Section.—"The Principles of Electronic Computing Machines" by B. V. Bowden, Ph.D., at 7.15 on March 24th at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

British Sound Recording Association

London.—"The Synchronization of Magnetic Tape and Film for the Amateur and Professional" by N. Leevers, B.Sc., and E. W. Berth-Jones, B.Sc., at 7 on March 20th at the Royal Society of Arts, John Adam Street, W.C.2.

Manchester Centre.—Debate: "Musicians versus Technicians" at 7.30 on March 23rd at the Engineers' Club, Albert Square, Manchester. (Joint meeting with the Manchester Gramophone Society.)

Television Society

London.—"Television Aerial Equipment" by N. M. Best (Antiference, Ltd.) at 7 on March 12th at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Radio Society of Great Britain

"V.H.F. Aerial Developments" by F. Charman, at 6.30 on March 20th at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

British Kinematograph Society

Television Division.—"The Application of Television for Underwater Use" by G. T. Syminton, at 7.15 on March 25th at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1.

Society of Instrument Technology

Scottish Section.—"The Electron Microscope" by A. Sharp at 7 on March 27th at the Royal Technical College, George Street, Glasgow, C.1.

Junior Institution of Engineers

London.—"Electronics in Materials Handling" by L. Landon Goodman, B.Sc., A.M.I.Mech.E., A.M.I.E.E., at 7 on February 27th at Townsend House, Greycoat Place, London, S.W.1.

Institution of Electronics

North-Western Branch.—"Recent Advances in Understanding Semi-Conductors and their Application for Rectifier and Transistor Operation" by Dr. J. S. Blakemore (Standard Telecommunication Laboratories), on February 27th.

"Modern Developments in the Technique of High Vacuum Measurements" by J. Blears, B.Sc. (Metropolitan-Vickers Electrical Co.), on March 27th.

Both meetings will be held at 7 at the College of Technology, Manchester.

Synthetic Radar Trainer

Electro-mechanical Equipment for Simulating Flight Paths of Aircraft

Interior of a part of the radar control room at London Airport.

RADAR is now becoming such an important factor in the handling of air traffic at the larger airports that the adequate training of ground radar control officers in the use of the equipment is becoming a serious problem. The most pressing need is to give the embryo controllers sufficient experience in the correct interpretation of the display shown on the P.P.I. (plan position indicator) cathode ray tube.

The amount of time each trainee can spend on familiarizing himself with the display has hitherto been governed to a large extent by the cost of maintaining aircraft in the air for ground instruction alone, on the availability of aircraft and on weather conditions.

As the handling problems that arise when fast and slow aircraft are mixed—as they are in the vicinity of any large airport—cannot be reproduced by using slow aircraft only for training, some fast types must be employed from time to time, and costs rise alarmingly.

In order to find a solution to some of the mounting problems now being encountered in training ground controllers, the experimental section of the Ministry of Civil Aviation has developed a synthetic radar trainer which will reproduce faithfully the flight paths of aircraft as they would be seen by a modern Surveillance radar.

This new trainer will be used at the M.C.A. Air Traffic Control School at Hurn, and it is estimated to effect a very considerable saving both in time and money. A normal course, for example, which hitherto covered eight weeks, will be reduced to six, and the actual flying hours of aircraft for training purposes will be reduced by 25 per cent, or about 50 hours actual flying time.

Electro-mechanical equipment figures largely in the new trainer. On a rough estimation the trainer is about half mechanical and half electronic, but valves and circuits are used only where it is not practicable to produce the required "information" for the cathode-ray display tube by mechanical means. The flight path of the simulated aircraft is provided by an electro-mechanical calculator which gives continuous indication of bearing, range and speed in relation to

The three units comprising the new M.C.A. Surveillance radar trainer. Only two of the four bays of the main rack are shown.

Control unit for "flying" the synthetic aircraft. Dials are standard types used in aircraft and all manoeuvres of a real aircraft can be simulated.

the assumed position of the radar, this being the origin of the radial time base sweep on the tube. It also makes correction for wind on the flight path of the aircraft.

The prototype trainer which was demonstrated recently has provision for providing tracks of up to four aircraft, but it only needs duplication of certain parts to provide almost any desired number of tracks.

As a matter of interest there is in course of development for production by the Marconi Company a radar trainer based on this design and employing the same principles. International Airadio are also interested in the production of a synthetic trainer to the same design and intended for training GCA (ground controlled approach), as well as airways controllers. The basic Marconi trainer will enable two "aircraft" to be flown independently, the flight paths and all other information appearing on the PPI display being exactly as would be seen with a genuine radar. By duplication of certain units 24 independent aircraft tracks can be simulated.

This trainer will be capable of being integrated into any existing radar system, so it will be possible for training purposes to mix synthetic tracks with the genuine for the purpose of studying different handling techniques. Another use would be for Service training, where real aircraft could be used as targets and synthetic aircraft introduced to study interception tactics.

As demonstrated by the M.C.A., the trainer consists of three main units. One is a four-bay Post Office type rack, a part of which is shown in one of the illustrations, the second is a PPI console as used with a genuine radar, and before which the trainee sits, while the third is a small control unit used by the instructor to "fly" the aircraft. Ex-pilots will normally be employed in this rôle. Up to four control units can be employed, but if simple flying manœuvres only are attempted one pilot-instructor could control them all. With some of the more complicated manœuvres possible with the equipment each control unit may need individual attention.

The control unit, a close-up of which is shown in one illustration, enables the following information to be passed to its electro-mechanical calculator (the second bay from the left in the rack assembly):—(1) Bearing of aircraft from 0-360 deg; (2) range from 2 to 90 nautical miles, both in relation to the assumed site of the radar; (3) windspeed up to 50 knots; (4) wind direction over 360 deg; (5) aircraft airspeed between 150 and 450 knots, and (6) three rates of turn, or change in direction of aircraft, based on the recognised scale of $\frac{1}{2}$, 1 and 2 in this ascending order.

It is possible also to simulate the following characteristics of a genuine radar:—(*a*) Amplitude of radar "blip" or echo; (*b*) radar pulse width from 1 to 5μ sec; (*c*) radar beam width from 1 to 5 deg at half-power points; (*d*) speed of aerial rotation from 0 to 30 r.p.m.; (*e*) permanent echoes and (*f*) range markers on c.r. tube.

It is understood the Marconi version of this trainer will provide synthetic air speeds of 150 to 600 knots and a simulated maximum range of 200 nautical miles.

NEWS FROM THE CLUBS

Aberdeen.—The Aberdeen Amateur Radio Society is to issue a certificate to amateurs who contact four member stations of the Society during Coronation year. Also, transmitters in any other Aberdeen will be elected honorary members of the Society. Claims should be sent together with 2s 6d (50 cents Canada, U.S.A. and possessions) to the A.A.R.S., 1-6, Blenheim Lane, Aberdeen, Scotland.

Birmingham.—In addition to the regular general meetings on the second Monday of each month the Birmingham and District Short Wave Society now holds a meeting on the fourth Monday to assist members with technical problems and to give morse instruction. The Society meets at the Colmore Inn, Church Street, Birmingham. Sec.: A. O. Frearson, 66, Wheelwright Road, Erdington, Birmingham, 24.

Birmingham.—"Radio Fundamentals" is the title of the lecture to be given by W. E. Merrill to the Slade Radio Society on March 6th. On the 20th A. F. Poynton will speak on "Television Tubes, Focusing and Deflection Systems." Meetings are held at 7.45 at the Club Headquarters, The Church House, High Street, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Brighton.—R. T. Parsons, secretary of the Brighton and District Radio Club (G3EVE), will give his radio autobiography at the club meeting on March 3rd. The club meets at 7.30 each Tuesday at the Eagle Inn, Gloucester Road, Brighton, 1. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton.

Cleckheaton.—Dr. G. N. Patchett, who is a frequent contributor to *Wireless World*, will be speaking on "Time Bases and Interlacing" at the meeting of the Spen Valley and District Radio and Television Society on March 11th. A demonstration of colour television will be given by Dr. J. B. Lovatt at the meeting on March 25th. Meetings are held on alternate Wednesdays at 7.30 at the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds.

Coventry.—The March programme of the Coventry Amateur Radio Society includes a lecture by F. Bowman (G3FAB) on "Applications of Wavemeters" (2nd) and another on "Mathematics" by T. R. Theakston (30th). Meetings are held on alternate Mondays at 7.30 at the Y.W.C.A., Queens Road, Coventry. Sec.: K. Lines, 142, Shorncliff Road, Coventry.

Peterborough.—S. Woodward, secretary of the Peterborough Radio and Scientific Society (G3DQW), will speak about electronics in industry and recent television developments at the meetings on March 5th and 26th, respectively. The subject on the 12th is field direction finding (R. H. Houtby) and on the 19th commercial short-wave receivers (C. J. Guscott, chairman). In addition there is a lecture each week for those wishing to take the Radio Amateurs' Examination. The Society meets at 7.30 at its headquarters in St. Paul's Road. Sec.: S. Woodward, 72, Priory Road, Peterborough.

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★ The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 31 lbs.

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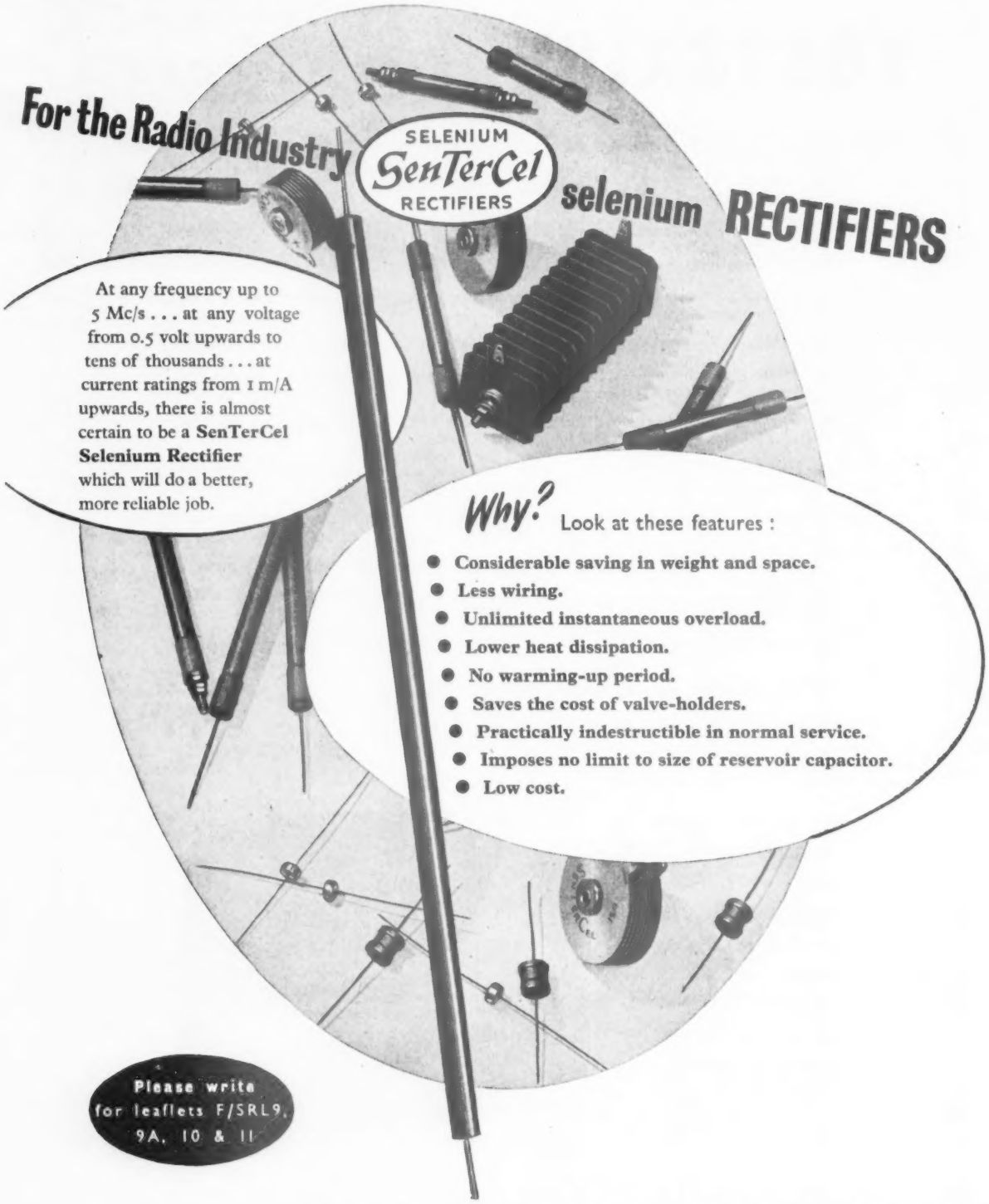

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TRANSISTORS

2—Basic Theory of the Earthed-base Circuit

By THOMAS RODDAM

IN the first part of this article I provided a rather discursive introduction to the transistor: readers who are familiar with the properties of transistors may, even as I write, be complaining that I have told them too little about too much. This month I propose to redress the balance by telling you too much about too little.

There was a time when it was fashionable to argue in these columns about the best equivalent circuit for a valve. There was, though you may not remember this, a time when it was fashionable to argue about the existence of sidebands. We are all more sophisticated nowadays, and I do not expect to see any arguments about the *best* equivalent for the transistor, though there may be differences of opinion about which is the most convenient. Equivalent circuits are particularly important in transistor circuit design, because there is much more interaction between input and output than there is in a valve, so that a change of load impedance will produce a change of input impedance. Unless you know what you are doing, cascading transistor amplifiers becomes as tricky as cascading tuned-grid, tuned-anode valve amplifiers at 60 Mc/s.

A second problem in amplifier design is the problem of biasing. With a valve we can put a resistance in the cathode circuit, knowing that for d.c. at least it provides negative feedback and thus has a stabilizing effect on the working point. With a transistor in the earthed-base connection we can get the right sign for the bias by putting a resistance in the base connection to earth, but, as I indicated in last month's article, this gives positive feedback. We could decouple, of course, but at d.c. the positive feedback would be there to upset the working point.

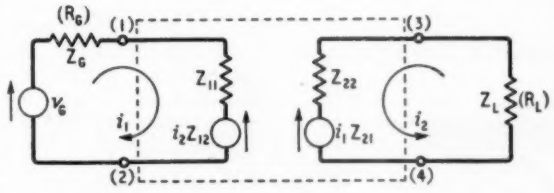


Fig. 1. General form of the equivalent circuit of a transistor, represented as a four-terminal device containing two internal generators connected between a generator and a load.

First of all, what are we to use as an equivalent circuit? The most general circuit we can use is that shown in Fig. 1. The transistor itself is shown inside the dotted rectangle, with a generator v_G of impedance Z_G connected to the input and a load Z_L connected to the output. The basic network equations may be written down:

$$i_1 (Z_G + Z_{11}) + i_2 Z_{12} = v_G$$
$$i_1 Z_{21} + i_2 (Z_{22} + Z_L) = 0$$

From these two equations it is only a question of ordinary manipulation to work out that the input impedance, looking in at (1), (2), is:

$$Z_{in} = Z_{11} - Z_{12} Z_{21}/(Z_{22} + Z_L)$$

and the output impedance, looking in at (3), (4), is

$$Z_{out} = Z_{22} - Z_{12} Z_{21}/(Z_{11} + Z_G)$$

Notice how Z_L appears in the expression for input impedance, while Z_G appears in the expression for output impedance. Notice also that if we make $Z_L = 0$ the input impedance becomes $(Z_{11} Z_{22} - Z_{12} Z_{21})/Z_{22}$. We shall see when we have some numbers to put in that this quantity is negative for a point transistor, so that for a short-circuited output the input impedance is negative. Any load capacitance will be such a short circuit at a sufficiently high frequency: our only salvation lies in the fact that the transistor itself will not amplify at very high frequencies.

This equivalent circuit has a very high-class look, and it is, indeed, the sort of four-terminal network you meet in the most superior treatises. It happens, however, to be the network which lends itself most easily to measurement. Let us see how we can perform the measurements. Suppose that we connect a low impedance generator to terminals (1), (2) and a low-impedance ammeter to terminals (3), (4). We need not calculate the relationship between the input voltage and output current, because the system will be unstable and will oscillate furiously. What we must do is to connect a very high impedance generator to terminals (1), (2), so that we force a current $i_1 = v_G/R_G$ into the circuit, whatever the input impedance may be. The terminals (3), (4), are left open-circuited, but we can apply a voltmeter across either (1), (2), or (3), (4). The open-circuit makes $i_2 = 0$, and we thus find that across terminals (1), (2), there is a voltage $i_1 Z_{11}$ and across terminals (3), (4), a voltage $i_1 Z_{21}$. The process can now be repeated with the current forced in at (3), (4), and we can measure $i_2 Z_{22}$ and $i_2 Z_{12}$. In a typical measuring set for transistors the current used is 100 microamps at a frequency of 5,000 c/s. The ordinary polarizing supplies can be fed in through inductances which do not shunt the impedances to be measured unduly.

It does not take very much consideration to see that any of the Z's can be expressed in the form

$Z_{mn} = dV_m/di_n$, with the other current held constant. This means that if we plot a family of curves of V_m against i_n, the slope of any constant current line is the corresponding Z. For the transistor we can get the four sets of curves shown in Fig. 2*, suffixes "e" indicating input or "emitter" and "c" "collector" or output voltages and currents. A typical working point in this set of characteristics might be $I_e = 0.5$mA, $I_c = -2.0$mA giving $V_c = -25$ volts and $V_e = +0.1$ volts. At this point we have, regarding the impedances as resistive, $R_{11} = 800$ ohms, $R_{12} = 300$ ohms, $R_{21} = 60{,}000$ ohms, $R_{22} = 25{,}000$ ohms. As you see $(R_{11}\ R_{22} - R_{12}\ R_{21})$ is positive at this point, but it is a near thing, and if R_{11} were 700 ohms instead of 800 ohms the quantity in brackets would be negative.

For circuit design purposes it is more convenient to use a transistor equivalent network which contains only one generator. This statement, of course, assumes that such a network can be found. There are, in fact, two useful equivalent networks for the point transistor, just as there are for the ordinary valve.†

For the point transistor the two equivalent circuits are those shown in Fig. 3, one of which incorporates a voltage generator $r_m i_e$, the other a current generator αi_e. The first of these is the form which corresponds to a valve equivalent of $g_m e_g$ in parallel with the valve impedance, the second corresponds to the more commonly used valve equivalent of $-\mu e_g$ in series with the impedance. As we must always remember, in designing point transistor circuits, the resistances in valve circuits convert to conductances in transistor circuits, and vice versa. The mutual conductance of a valve becomes the mutual resistance r_m in the transistor circuit, the voltage amplification factor of the valve, μ becomes the current amplification factor α, of the transistor.

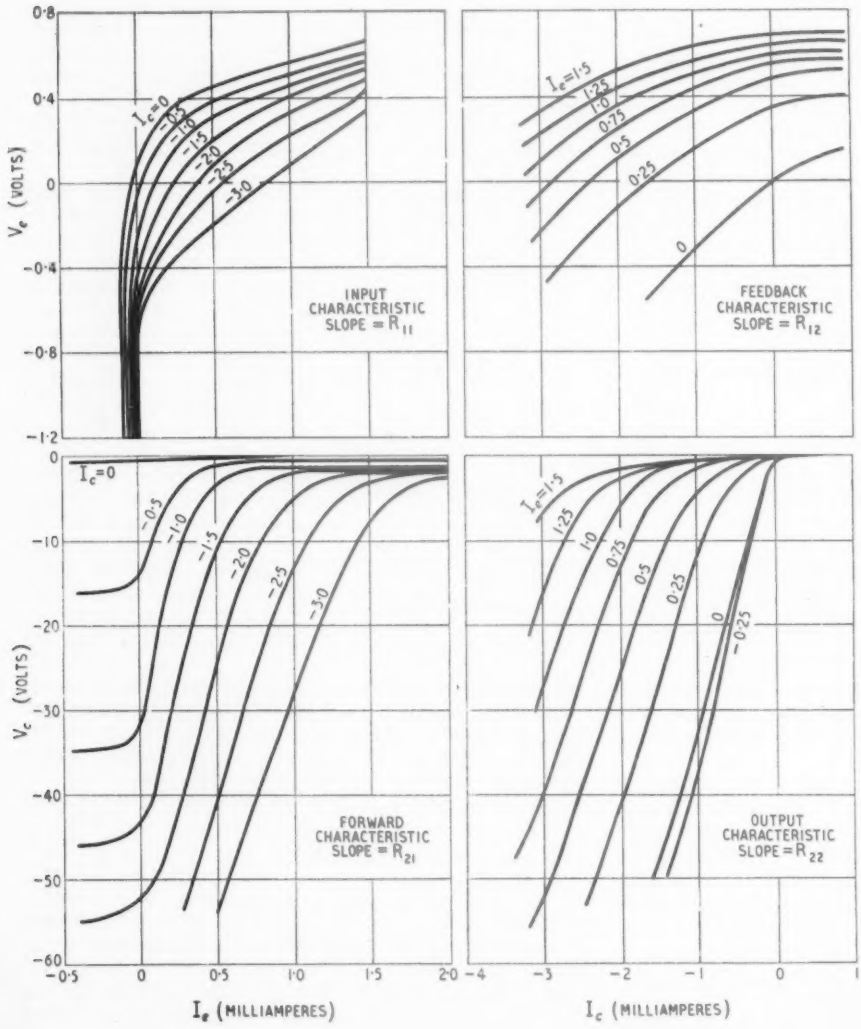
If the base resistance r_b is taken as zero, the transistor input impedance in the earthed-base connection becomes just r_e. An ideal transistor would have $r_e = 0$, just as an ideal valve has an infinite input impedance at the grid. A practical transistor has a value of r_e in the region of tens or hundreds of ohms: the users of electrometer valves regard the leakage across the grid-cathode circuit of a standard receiving valve as an equally large deviation from the wanted value.

When r_b is allowed to return to its normal value, the odd hundred ohms or so, there are two effects. Assume first that the collector is open-circuited so far as any signal frequencies are concerned. There will be no collector current, except the standing current, which we are not concerned with. A signal applied to the emitter will drive a current through r_e and r_b in series and since this is the only signal frequency current in the circuit the input impedance will be $(r_e + r_b)$. This is the open-circuit input impedance, which we know to be R_{11}. Now allow some signal current to flow in the collector circuit by connecting a finite load to the collector. The collector

*Figs. 2, 3 and 4 of this article are based on Figs. 23, 4 and 7 respectively of the paper "Some Circuit Aspects of the Transistor" by R. M. Ryder and R. J. Kircher, *B.S.T.J.* Vol. xxviii, July 1949.

†It is of interest to digress for a moment: the expression "ordinary valve" has at present, a clear meaning, but the transistor is a valve, too. I am undecided whether to go American and use "tube," or whether to adopt a new term, the "free electron valve." This term, however, may suffer in clarity if used by people who lack a R.A.D.A. training, and we shall hear voices saying "three electron" valve, or "free electrode" valve. Then where shall we be?

Fig. 2. Representative static characteristics for the Type A transistor.



current loop is also closed through r_b so that r_b acts as a coupling resistance between output and input, and the input impedance is altered. We shall do the mathematics of this later.

We can repeat the process at the collector. With an infinite input impedance we can look in at the collector and see r_c in series with r_b giving $(r_e + r_b)$, or R_{22} When the emitter circuit is connected through a finite impedance, however, the current through the collector path divides between r_b and the path containing r_e. Any current in r_e, however, is a term i_e, which produces a voltage $r_m i_e$ in series with r_c. The amount of current in the collector path thus depends on the way the collector current divides between the r_b path and the r_e path, and this depends on the external impedance in the emitter circuit.

Various theoretical solutions are possible, one of which is to put in symbols for the two external resistances and calculate the conditions for maximum gain. This particular approach leads with great speed to the conclusion that you can get infinite gain, which is useful for oscillators, but not so good for amplifiers. The problem in practice is complicated further by the fact that these r's which look so simple in the diagrams, are by no means constant. In consequence, the process of design becomes in some ways more simple, in some ways more complicated.

The design of the collector circuit is quite simple. We take the collector voltage-current characteristics, the ones with emitter current as a parameter. On these we lay off a load line, just as we should if we were dealing with a valve. With point transistors we shall usually take a collector load of about 5 to 20 kΩ, the sort of value, indeed, that we take for most triodes. This will fix the working point, of course. On the emitter side we have a different problem. We could take the open-circuit impedance at the emitter as the load to which we match our generator. This gives quite good gain conditions. Unfortunately our signal source will be a voltage generator in series with a resistance, assumed now to be about equal to the load provided by the emitter circuit of the transistor. Roughly, then, the emitter current is $i_e = v_G/[R_G + (r_e + r_b)]$. The output will be a faithfully amplified version of i_e, but since $(r_e + r_b)$ is not constant, but varies over the cycle, and since R_G is not enough to swamp this, i_e is not the simple sine wave that v_G is. In fact i_e is quite distorted, and the distorted i_e is amplified and appears in the collector load.

A first step towards dealing with this difficulty is to make R_G very much bigger than $(r_e + r_b)$. We can do this by introducing an input transformer with a good step-up, just as we sometimes step down to a grid which is driven into the positive grid region. This will mean that there is a wide mismatch between the generator and the amplifier input. Suppose, for example, that $(r_e + r_b) = 250$ ohms, and we have a microphone of impedance 250 ohms at source. A 1 : 1 transformer would match the microphone to the emitter, neglecting feedback effects, but the distortion would be intolerable. We then use a 1 : 3.1 step up transformer, so that the microphone equivalent generator sees 275 ohms instead of 500, but only 25 ohms instead of 250 ohms is non-linear. We shall lose some decibels in gain : not very many, because the microphone will deliver 500/275 times the current, which will be stepped down 3 times in the transformer, so the emitter current is about 2/3 of what it would have been, a loss of 4 db. The only trouble is that the microphone is now mismatched, and it may not like

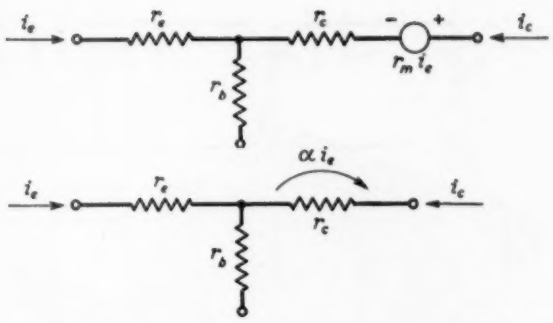


Fig. 3. The two most useful equivalent circuits for the point transistor are these, which contain only one generator.

this. We can add 225 ohms in series on the input side of the transformer, or 2,250 ohms in series on the emitter side, and we shall then be facing the microphone with 250 ohms, while the emitter current is linearized by the large total series resistance.

The numbers I have used here are quite fanciful. It is a matter of individual design to choose how far you will go with this linearization, and at present it does not seem profitable to try to calculate the amount needed. I am inclined to think that this method will be used less and less as transistors get cheaper and more plentiful, because the use of negative feedback for linearization is much better, and for this we need all the stage gain we can get.

One more point remains to be checked before going on to construct a single-stage amplifier based on this design process. We must use an equation which I shall derive later to check that the stage is stable. This equation settles the minimum collector and emitter impedances which are needed to prevent the base feedback producing instability. If it is found that the feedback is too great, either the emitter impedance or the collector impedance must be increased.

Experimental Precautions

Having determined the load line and the working points, and decided on a suitable input impedance transformation, the remaining point is to consider how the working point is to be fixed in practice. For the beginner there can be only one answer : supplies of about + 100 V and − 100 V should be used, and the appropriate large series resistors added to make them into approximately constant-current sources. Thus if the working point is −20 V, 4 mA at the collector and 2 mA at the emitter, we should take a 20-kΩ resistor in the collector lead and a 50-kΩ resistor in the emitter lead, and apply −100 V to the collector supply resistor and +100 V to the emitter supply resistor. Assuming that input and output transformers are used, we should decouple these resistors in the usual way.

It will be clear from what we have said that if we are taking 4 mA in the collector circuit we must have 4 mA divided between emitter and base. We want, in our arbitrary example, 2 mA to flow in the emitter circuit and 2 mA in the base. If we examine the emitter current-voltage characteristic, with collector current as a parameter, we can find the emitter voltage needed for this bias current. Suppose, for example, that we see we need −0.1 volts on the emitter. A resistance

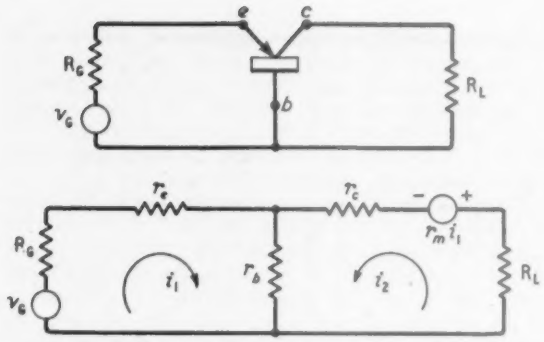


Fig. 4. Earthed-base transistor amplifier and its equivalent circuit.

inserted in the emitter lead will make the emitter more negative, and a value of 50 ohms would be enough to bring the emitter to the desired bias point. Very often, however, we find that we need +0.1 volt on the emitter. This is the same as making the base 0.1 volts negative with respect to emitter. The base current, $i_c - i_e$ is $4 - 2 = 2$ mA so that a 50-ohm resistor in the base lead will fix the bias where we want it. Unfortunately, as we have already indicated, the addition of resistance in the base circuit increases the positive feedback. We can decouple this external resistance in the base by means of a suitably large capacitor across it, but the positive feedback will be present at the lowest frequencies. The effect of this is that differences in d.c. characteristics between transistors are accentuated, just as differences in the d.c. characteristics of valves are reduced by the use of cathode bias resistors. If a transistor is to be driven up to its maximum capabilities, the working point must be chosen very carefully, and base biasing is then out of the question. When we turn later to the problems of *n-p-n* circuits we shall see that there are some compromise solutions which offer the advantages of emitter biasing without requiring two supply voltages of different polarities.

We must now deal rather more formally with the behaviour of the equivalent network. The circuit is shown in Fig. 4, and we can write down at once the two equations :

$$i_1(R_G + r_e + r_b) + i_2 r_b = v_G$$
$$i_1(r_b + r_m) + i_2(r_b + r_c + R_L) = v_L$$

It is now a matter of straightforward algebra to carry out the various calculations. We can put $v_L = 0$ and solve the two equations for i_1 and thus obtain i_1/v_G which is equal to R_G plus the input impedance. Similarly we can put $v_G = 0$ and solve for i_2 thus obtaining the output impedance. The results are :

Input impedance :

$$R_{11} = r_e + r_b - \frac{r_b(r_b + r_m)}{R_L + r_c + r_b}$$

Output impedance .

$$R_{22} = r_c + r_b - \frac{r_b(r_b + r_m)}{R_G + r_e + r_b}$$

Notice that R_L, the collector load resistance, appears in the expression for input impedance, while R_G, the emitter load resistance, appears in the expression for output impedance.

Now consider the conditions for stability. The equivalent input circuit is v_G in series with R_G and R_{11}, a total resistance of $R_G + R_{11} = R_G + r_e + r_b - r_b(r_b + r_m)/(R_L + r_c + r_b)$. This will only be positive if $(R_G + r_e + r_b)(R_L + r_c + r_b) > r_b(r_b + r_m)$, so that this is the condition for stability. The same result is obtained, as you might expect, by considering the output loop. Following established practice we can write $(R_G + r_e)$, the total emitter lead resistance, as R_E, $(R_L + r_c)$, the total collector lead resistance, as R_C and r_b with any external base resistance, as R_B and the stability condition can then be converted to

$$\frac{r_m}{R_C} < 1 + \frac{R_E}{R_B} + \frac{R_E}{R_C}$$

It is this stability criterion which was mentioned earlier in the article, the application of which is the final stage in the design process.

Further manipulation of the two equations gives the power gain as

$$G_0 = 4R_G R_L \left[\frac{-(r_b + r_m)}{(R_G + r_e + r_b)(R_L + r_c + r_b) - r_b(r_b + r_m)}\right]^2$$

As might be expected, this goes to infinity if the stability inequality becomes an equality. Otherwise it is a pretty cumbersome expression, and its chief value seems to be for comparison purposes with other circuit arrangements.

There are two points which may be discussed here. The first is that it is of great importance to notice that there is no phase shift in the transistor in the earthed-base connection. If the emitter is driven positive, the collector goes positive (less negative). The 180-degree phase shift of the ordinary valve is not obtained. In circuits using feedback, both negative and positive (oscillators !) this point is of course vitally important. The second point is that you will often find the earthed-base point transistor circuit compared to an earthed-grid valve. The earthed-base point transistor circuit has low input impedance—so has the earthed-grid valve. Both have high output impedances, both have input and output in phase. This analogy is a very tempting one, but so far I can judge from my own experience it is a thorough nuisance. The use of the duality principle seems to lead to much wider flexibility in the design of transistor circuits. In a later article I hope to discuss this question much more fully.

It will be obvious to the reader that if the earthed-grid analogy is plausible, we could apply a signal to the base, and take the output from the collector, hoping to get an analogy for the usual earthed-cathode valve circuit, or put the input on the base and take the output from the emitter in a sort of cathode-follower circuit. Both these circuits are quite possible, and in the next article I shall discuss them.

MARINE RADIO CAREERS

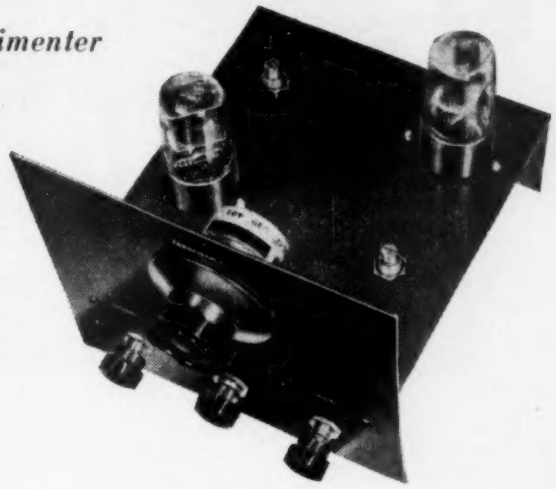
IT may not be known, generally, that full-time students at wireless schools who at the time of registration for National Service are training for the P.M.G.'s Certificates in Wireless Telegraphy may have their call-up deferred. Employment in the Merchant Navy does not, however, count as National Service, and men remain liable for call-up to the age of 26, but under the present arrangements members of the Service are not being called up.

The training and service conditions of marine radio officers are outlined in the brochure "Concerning a Career," produced by the Marconi International Marine Communication Company in co-operation with Siemens Bros. and Co. Copies of the booklet and further details of the Service are obtainable from Marconi House, Strand, London, W.C.2.

Oscillator/Filter Unit

A Versatile Instrument for the Experimenter

By A. Q. MORTON



The main control is of frequency and is coupled to the ganged resistors R_1 and R_7. Subsidiary controls are (left to right) attenuator (R_{15}), oscillator/filter switch and gain control (R_{16}). Pre-set resistor screws project through the base.

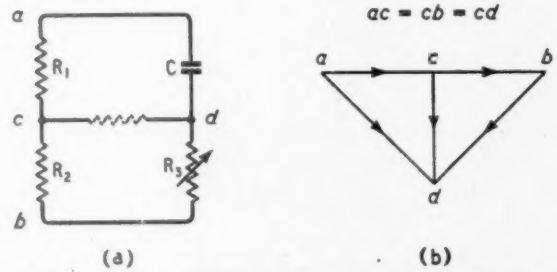
THE circuit upon which this unit is based is one which was developed in the United States, where the instruments are generally named and labelled with a particular application in mind.* Two double triodes of a type easily available as surplus are used in the circuit. One valve is a phase shifter in which any audio frequency within a range of about 100 : 1 is shifted 180 degrees ; the valve is used as an output stage and separate amplifier, and, depending on the connections, the instrument will be an oscillator or rejector at the chosen frequency.

The nucleus of the instrument is the phase shifter shown in Fig. 1 (a). A push-pull input is applied across two equal resistors R_1 and R_2 ; a capacitor and a variable resistor are in series across the same input. The point *c* is always at zero potential, it is connected by equal resistances to two points at equal and opposite potentials. An output across *c-d* will vary with the impedances of C and R_3. When these are equal the state is that shown in the vector diagram of Fig. 1 (b). The output is half the input and is 90 degrees out of phase with it. R_3 can therefore be varied to select any frequency to undergo the change of phase without change in amplitude.

In practice two stages are used to obtain a 180-degree shift and the variable resistors are ganged. It is not necessary for them to be accurately in step. R_1 and R_2 are made the anode and cathode loads of a valve, the push-pull input is then provided without complication, and the low values of resistor make it easier to avoid shunting effects, especially as the simple expedient of doubling the resistors of the second stage will enable it to be directly coupled.

An output stage follows to isolate the phase shift network and make good the loss of gain.

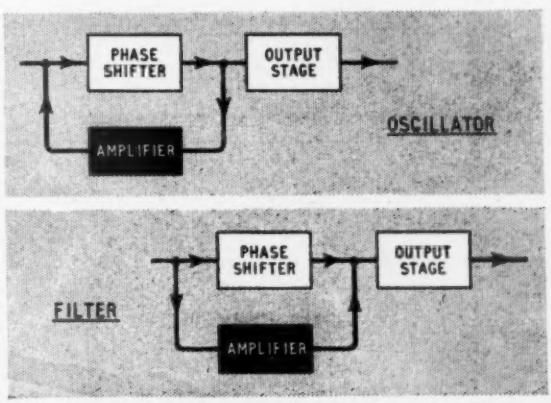
* "The Selectoject," by O. G. Villard and D. K. Weaver, *Q.S.T.*, Nov. 1949, p.11.



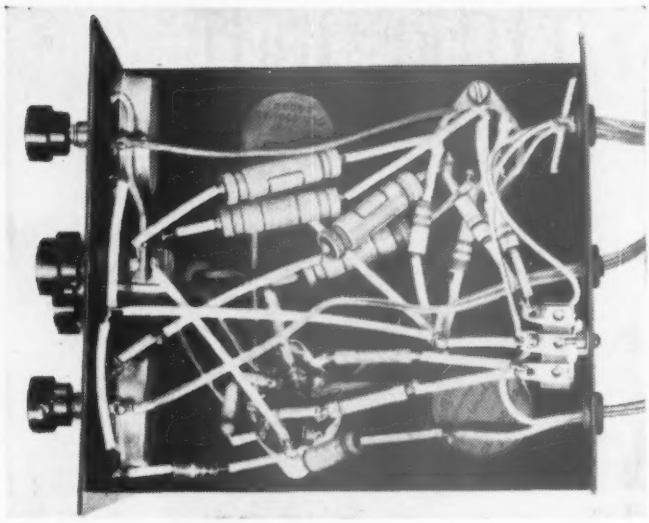
Above : Fig. 1. (a) Basic phase-shift network, and (b) one method of representing the phase relationships when the impedance of $C = R_3$.

The second double triode has provided another amplifier and gives the choice illustrated in the block diagram Fig. 2. If the output of the shifter is fed back to the input to give negative feedback this will take place at all frequencies except that selected for the 180-degree shift. For this frequency the feedback will be positive, and if the gain is over 4 times, oscillation will take place. If the amplifier and phase shift input and output are paralleled, then at the selected frequency cancellation will take place and the instrument becomes a filter, for example, a whistle suppressor.

The performance of the instrument depends mainly on the balance of the phase-splitter stages. A half-watt, high-stability resistor makes a good anode load, and a fair performance is obtained if the cathode resistor is a similar type within 1 per cent of equality. It is better, and not much more expensive, to use a wire-wound resistor of the screwdriver-adjustable type, and, having matched them by a d.c. measurement,



Right : Fig. 2. Reversal of the amplifier connections converts the unit from oscillator to filter.



Underside of chassis. In this version, pre-set wire-wound resistors are used for R_2 and R_5.

to try slight variation at the high-frequency end of the scale.

The range depends on the ratio of maximum to minimum resistance of the two sections of the main control. Using a standard carbon track this should not be less than 100 : 1 and is often 120 : 1. A linear scale is given by a linear-law resistor. For some uses, e.g., as an oscillator, a log scale is more convenient, but for use as a whistle filter the linear law is likely to be easier to adjust. With the values shown the coverage should be 90–9,000 c/s.

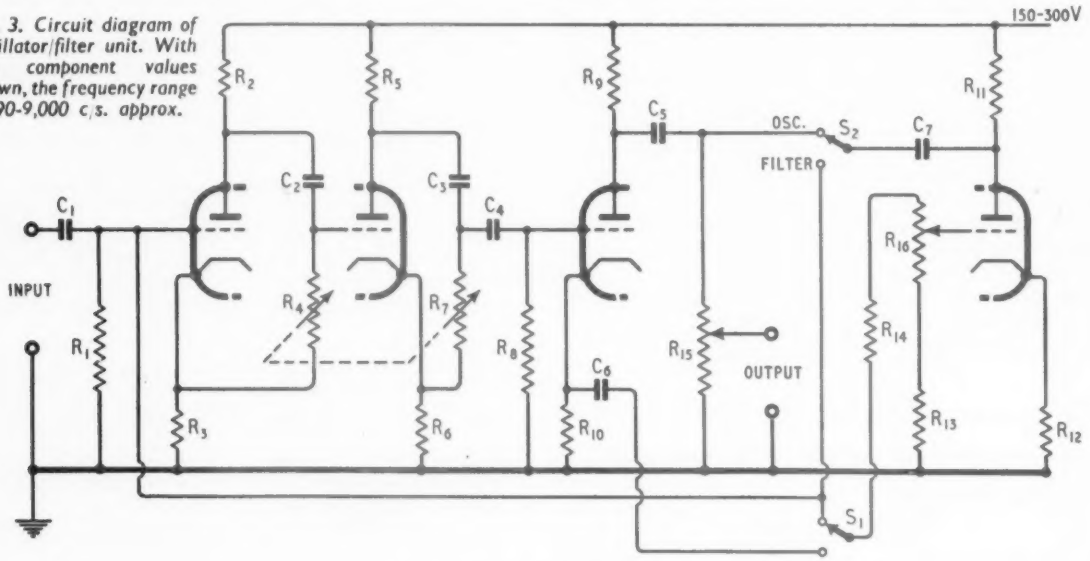
As an oscillator the performance is surprisingly good. If the control is set so that oscillation is just established, the amplitude variation will not exceed 1.5 db over the range, and harmonic distortion will not exceed 1 per cent. Before the onset of oscillation the amplifier is highly selective, the rejection of second harmonic in bridge use is at least 40 db.

As a rejector the performance depends to a large extent on the operator. With careful setting the rejection is superior to most " twin-T " networks.

The real attraction of this instrument is its remarkable simplicity and flexibility. Attempts to add refinements are not always successful. For example, switching-in additional capacitors will not extend the *range* of the control, for the added stray capacity will destroy the balance earlier, and the only effect is to shift the scale. The phase shifters can be used as a source of quadrature voltage for the generation of polar time bases, but for any degree of accuracy the ganged resistors will need to be in step. This demands a better resistor, and a happier solution is to incorporate a phase shifter in the time base.

Of the possible uses a few may be mentioned. It makes a general purpose audio oscillator; it is a convenient source for bridge work and can also be used as a selective amplifier before the detector; it will make an excellent whistle filter or resonance suppressor in radio or gramophone service. As a bandpass or bandstop filter of variable centre frequency and bandwidth it is handy in intermodulation testing, and as an adjunct to a communication receiver it can be used to boost a weak c.w. signal above prevailing background noise or to reject an unwanted one.

Fig. 3. Circuit diagram of oscillator/filter unit. With the component values shown, the frequency range is 90-9,000 c/s. approx.



LIST OF COMPONENTS

R_1	1 MΩ, ½ W, 20 per cent.	R_8	5 MΩ, ½ W, 20 per cent.	R_{15}	100 kΩ, variable output control.
R_2	1 kΩ, ½ W, high-stability.	R_9	47 kΩ, ½ W, 20 per cent.	R_{16}	25 kΩ, variable gain.
R_3	Either as R_2, to match within 1 per cent, or pre-set control.	R_{10}	2.2 kΩ, ½ W, 20 per cent.	C_1, C_4, C_5, C_6, C_7	0.01 μF, 350 V, 20 per cent.
		R_{11}	47 kΩ, ½ W, 20 per cent.	C_2, C_3	2,700 pF, 5 per cent.
R_4, R_7	Two-gang 0.5 MΩ, carbon.	R_{12}	2.2 kΩ, ½ W, 20 per cent.	S_1, S_2	Double-pole, double-throw switch.
R_5	2.2 kΩ, ½ W, high-stability.	R_{13}	10 kΩ, ½ W, 20 per cent.	Valves	Two 6SL7.
R_6	To match R_5, as above.	R_{14}	15 kΩ, ½ W, 20 per cent.		

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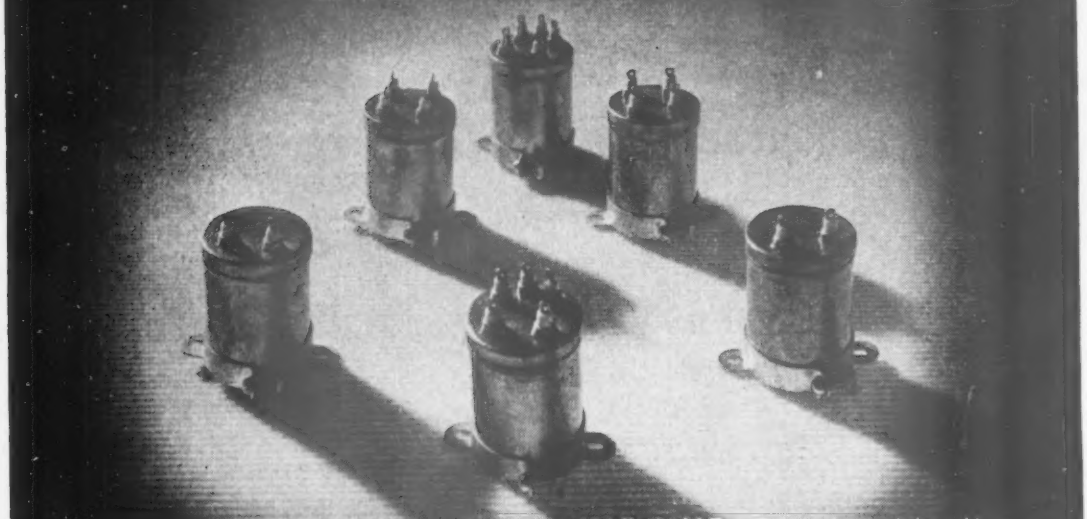

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ATTENUATORS

By "CATHODE RAY"

Keeping them Matched to the Source and the Load

ONE of the minor curiosities of our technical language is that when the thing shown in Fig. 1 is incorporated in a mass-produced receiver it is called a *volume control* but when it is in a signal generator it is dignified by the name *attenuator*. Incidentally, it is also commonly called a potentiometer, though this is really the name for an elaborate piece of apparatus used in standardizing laboratories and likely to cost a hundred pounds or more. Realizing this, the people who are careful with their words call Fig. 1 a *potential divider*; but unfortunately, for some inscrutable reason, this term is usually understood to refer to combinations of *fixed* resistors. It is all very muddling.

BS.204 ("Glossary of Terms used in Telecommunication") defines an attenuator as:

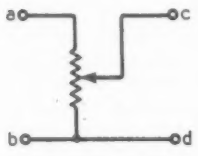


Fig. 1. Is it or is it not an attenuator?

"A network designed for insertion in a line, or between other networks, to introduce a variable loss without introducing distortion or change of impedance."

And if you ask, "What about fixed attenuators?" the answer is in the next definition:

"*Pad:* A network designed to introduce a fixed loss and also used between two lines of equal or unequal impedances."

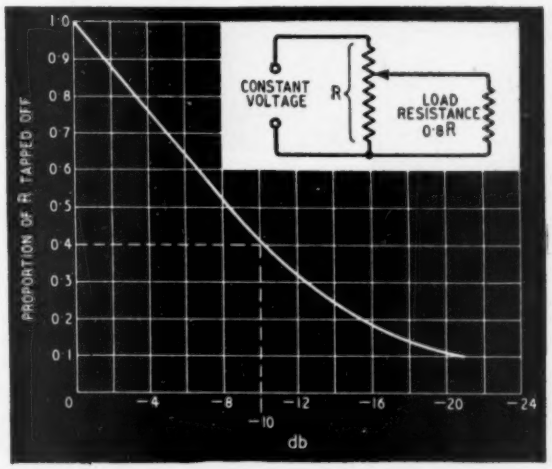
This, I feel, is not as well worded as it might have been; among other things, the significance of the "and also used" is not too clear. To avoid having to say "attenuator or pad" every time I am going to use "attenuator" to include both fixed and variable "lossers."

Elsewhere in BS.204 "loss" is defined as a decrease in power, so it looks as if Fig. 1 has to renounce all claim to official recognition as an attenuator, for it is on the horns of a dilemma. If it works into an open circuit, it introduces a loss of voltage, not power; and if it works into anything that accepts power it cannot vary the power without varying its input impedance. In radio practice, it is most often used to control signal *voltage*, terminal *c* being connected to the grid of a valve so as to supply negligible current. I suppose the combination of volume-control and valve might come within the definition of attenuator, unless it is objected that all valves introduce distortion, or that a valve is not a network. For the present purposes I will uphold this objection, for I have no desire to have valves brought into the discussion.

Sometimes even in radio one wants to control the power going into some kind of impedance. Evidently what one needs, according to the book, is an attenuator. But if one looks up the literature on attenuators the subject appears very forbidding, with all sorts of strange looking things like coshes and tanhs flying about—the latter presumably being the last dying gasp following a blow delivered by the former. So the temptation is to stick to the good old pot'meter or volume control. The beauty of it, in its proper functions as a potential divider, is that all one has to do is to choose its resistance to suit the impedance of the source across which it is connected (at *ab* in Fig. 1); then the output voltage is simply proportional to the amount of the resistance tapped off between *cd*.

But if an appreciable load is connected between *cd* two complications arise. The first is that the input impedance (i.e., what the source sees, looking into the terminals *ab*) varies with the setting of the control. (Incidentally, so does the output impedance—what the load sees, looking back into the terminals *cd*—but that is so anyway.) The second complication is that the output is no longer simply proportional to the resistance, but both the amount and the scale-shape depend on the load impedance. This change from the simple linear scale of the open-circuited divider is sometimes used for obtaining a special scale shape without having to have a graded or "tapered" resistance winding. For instance, if a linear variable potential divider (i.e., one in which the resistance between *cd* is directly proportional to the uniform-scale reading) is connected to a load resistance 0.8 times its own full resistance, then if a constant voltage is maintained between *ab* the scale from maximum down to 0.4 times maximum can be divided uniformly into 0 to −10 db without serious error; see Fig. 2. The db scale is reasonably uniform over this range with any load resistance from 0.7R to R,

Fig. 2. A simple potential divider has a practically uniform decibel scale from 0 to −10 if it is used to control the power in a load having 0·8 times its own resistance.



but of course it opens out or closes up slightly as the load resistance is varied. Although this scheme looks very nice on paper, it is not quite so useful as it looks, because the input resistance varies from 0.444R to R as the slider is moved from top to bottom, so the input voltage is not likely to remain constant. And of course the output resistance varies vastly.

Results of Mismatching

We radio people don't usually bother a great deal about matching impedances every time we connect anything to anything else. An exception is the output stage of a power valve; the impedance of the loudspeaker or other load has to be reasonably near the optimum specified by the maker of the valve. Now that negative feedback is customary, even that is not quite so critical as it used to be with the early types of power pentode. And for domestic purposes one seldom controls the volume between valve and speaker; controls of volume, gain, or what you will, are nearly always arranged at the inputs of valves, where the impedance problem is dodged.

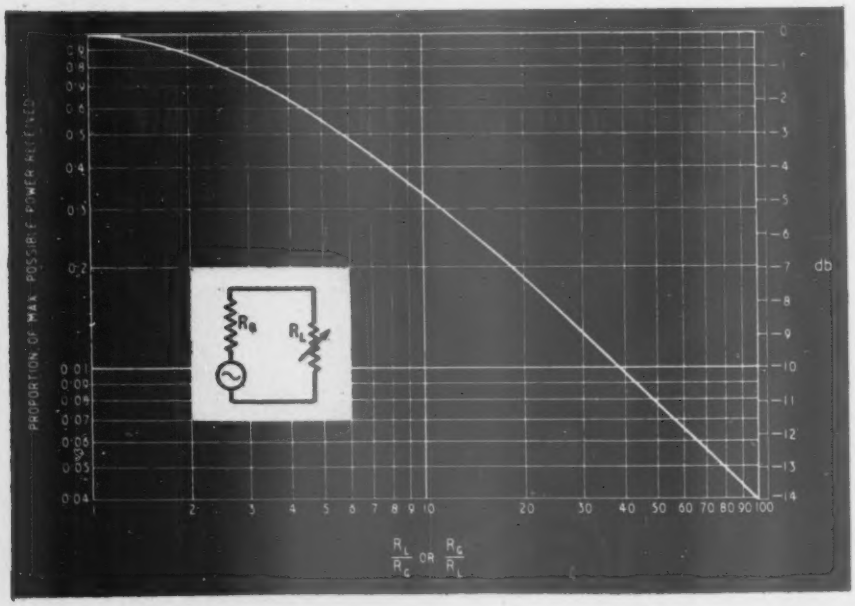
In sound distribution systems it is another matter; and now with television we are having to consider impedance matching when connecting aerials, feeders, and receivers. But this is nothing to what the line communication people have to do.

Why is impedance matching important? Does it matter if it is not done?

There are several effects of mismatching, not all of which might matter in any particular case. The first effect is a power loss. There is a well-known general rule that the greatest power is delivered to a load when its resistance is equal to the resistance of the source of the power. (I shall stick to simple resistance and not confuse the issue with reactance.) The maximum power thus obtained is half the amount generated; the other half is lost in the source. This rule includes valves as sources of power, but in valves it is usually overridden by considerations of distortion—which is one reason why I want to leave valves out of it. The point is that if a giver and a receiver of power are connected together, failure to make the input resistance of the receiver equal to the output resistance of the giver—in brief, to match impedances—results in a loss of power transfer; the greater the mismatch, the greater the loss. The actual amount of loss for a given mismatch is shown in Fig. 3; you may be surprised to see that a 2 : 1 mismatch loses only a fraction of 1 db.

This leads to special complications when the connection is made through a long line. As I explained in the July and August 1950 issues, when power starts to flow along a cable it can't know what the impedance of the load at the far end is going to be, so its rate of flow is determined at first by the "characteristic impedance" of the line itself. If, when the power arrives, it finds the load impedance is wrong, it delivers what it can and takes back what it can't; this being known more officially as reflection. The reflected power is one and the same thing as the power loss due to mismatching, but owing to the distance between source and load we have power travelling in both directions at once. If there is another mismatch at the starting end, reflection occurs there too, and a proportion of the rejected power presents itself at the load a second time, after a delay due to its double journey. This, if an appreciable fraction of the original signal power, would have deplorable results in television, producing one or more "ghosts." Actually, a length of television feeder long enough to produce a time delay that can be seen on the screen usually dissipates sufficient power in itself to reduce such ghosts to the vanishing point, except perhaps if mismatching is altogether excessive. In radar systems, however, reflection effects may be serious unless matching is fairly exact.

Fig. 3. The load resistance (R_L) that receives most power from a given generator is equal to the generator resistance (R_G); the loss is then 50% or 3 db. This graph shows the additional loss when R_L is not equal to R_G.



But this is getting away from attenuators. To take a practical radio example, suppose one has a 2½-Ω loudspeaker, to be driven from a valve with an optimum load resistance of 5,000 Ω. The usual matching device is a transformer, and the required ratio is $\sqrt{(5{,}000/2\frac{1}{2})}$ = about 45 to 1. If it were a perfect transformer its primary terminals, with 2½ Ω connected to the secondary, would appear to the valve as a load of 5,000 Ω, so the valve would be at its happiest. To the loudspeaker coil the transformer, with the valve connected to the primary, would look like a valve with an optimum load of 2½ Ω; so it would be happy too. Now suppose an attenuator is to be interposed to control the power reaching the speaker. It can be inserted on either primary or secondary side of the transformer, but

either way it should be so contrived that at all settings neither valve nor speaker will notice any difference. They ought both to be connected to the same resistances as before.

The same principle applies to line communications, only more so. All sorts of apparatus—amplifiers, attenuators, filters, etc.—may have to be connected one into the other, and to make this a reasonable proposition it is necessary to have a standard impedance so that they will all match one another; 600Ω is the most-used. The whole system is a chain of units, each having the same input and output impedance. If you are remembering that there is a 50% power loss in transfer between two perfectly matched units, you may at first think that each unit must lose that much of what is put into it, so that a system made up of many units must at the best be extremely inefficient. But it must be realized that the input impedance of any unit is reckoned *with its output terminals connected to a matched impedance.* Similarly, output impedance is reckoned only when the input is connected. Fig. 4(a) shows three connected units, all matched. Call their common impedance R. Then although the middle unit looks to both the others like a resistance R, this does not necessarily mean that the middle unit itself has any resistance or absorbs any power. For all they know it may contain nothing more than a pair of straight-through connecting wires, as at (b): Here the end units are represented by their resistances. If the source is disconnected and an ohmmeter substituted, it shows the input resistance is R ohms; and it is the same with the output resistance. With such internal connections, the middle unit might be an attenuator set to give zero attenuation. Whatever resistors an attenuator may contain, none of them must be in circuit—either series or shunt—at the zero setting.

Next, suppose we want to switch in some attenuation, to reduce the power in the load. Either series or shunt resistance would give us any amount of attenuation we wanted, but the system would no longer be matched. Series resistance would increase both input and output resistance of the attenuator; shunt resistance would reduce them. So a combination of both is needed. Now if you try putting one resistor in series and another in shunt you will see that however they are arranged the combination is lopsided. If the shunt is across the input terminals, then the input impedance is less than the output impedance; and vice versa. Clearly at least three resistors are needed for the attenuator to look like a resistance R from both ends. The two simplest arrangements are the T and the π, as in Fig. 5. One can see straight away that for equal input and output resistances they must be symmetrical; the two series resistors in the T must be equal, and so must the two shunt resistors in the π. The actual values of the resistors to give any desired attenuation can be calculated by simple formulæ, or looked up in tables. They are available in all the reference books on communication engineering, and there is an attenuator abac in *Radio Data Charts.* The formulæ for the two types in Fig. 5 are given at the end of this article. It is quite easy to see what the resistances should be for infinite attenuation; i.e., no power to reach the load. The shunt resistance of the T would have to be zero, and to keep input and output resistances right the series arms would each have to be equal to R. In the π, the series arm would have to be infinity—an open circuit—and the shunt arms each equal to R.

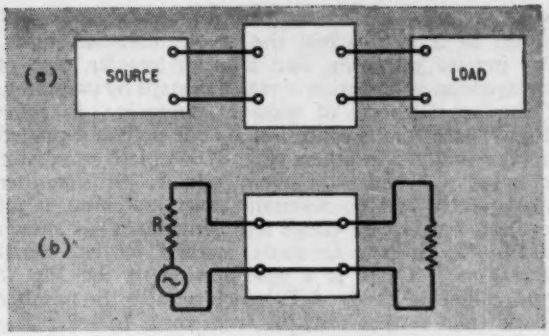


Fig. 4. Diagram (a) represents a unit matched at both ends to a source and load, having input and output resistances =R. At (b) the source and load are shown as they appear to the unit, which in this case has no resistance in itself, but because of its terminations it appears to both source and load as a resistance R.

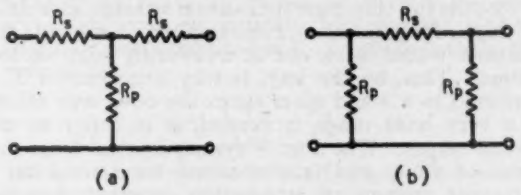


Fig. 5. The two simplest forms of attenuator capable of providing any amount of attenuation and at the same time matching equal input and output resistances

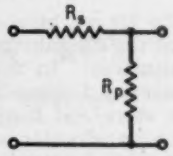


Fig. 6. This L type can provide any amount of attenuation and match any resistance at the end connected to R_s.

Sometimes it is good enough to keep the resistance right at one end only. For instance, it might be necessary for the generator to have a constant load, whereas the resistance across the load didn't much matter. In such cases one can make do with a two-arm attenuator, usually called the L type (Fig. 6). If you compare this with Fig. 1 you will see that in form it is exactly the same. But that doesn't mean that an ordinary "pot" will do. To keep the input resistance constant, the two arms have to be correctly proportioned, which means that their total resistance as the attenuation is varied cannot be constant.

Varying the Attenuation

This raises the question of how to do the variation in practice. One way is to make the attenuator arms ganged rheostats. It is rather complicated, because the shunt and series arms must have quite different "laws," and these call for rather tricky tapering of the resistance elements. But it can be done, if the range of attenuation to be provided is reasonable. For example, it would be unreasonable to expect the attenuation to be continuously variable down to zero, for that would necessitate a shunt resistance continuously variable up to infinity. Unless the attenuator were needed for precise measurements, however, a little mismatching would do no harm and one would

probably arrange for the shunt rheostat to open-circuit as it approached the zero-attenuation mark. For precise purposes, and also for greater ease of construction, attenuation is varied in steps by switching. There are all sorts of ways of doing it: in some (Fig. 7) each arm is controlled by one pole of a ganged tapping switch; in others (Fig. 8) complete attenuator units are switched in or out of circuit. Still another way—which fails to maintain exact matching at all settings, but is very cheap and convenient—is shown in Fig. 9; it is a favourite method for r.f. signal generators. There is a modification of the Fig. 7 type, called the Bridged-T, which reduces the number of switched sets of resistors from three to two; the two series arms in the T are both fixed at value R, and a single switched arm is added as a by-pass to them both.

In theory, a single stage is all that is needed to provide any attenuation, but in practice it is not a good idea to try to cover a very wide range with one stage. For one thing, stray capacitance would tend to by-pass the very high attenuation settings, especially at high frequencies. For another, some of the resistors would work out at awkwardly high or low values. This, by the way, is why sometimes a T is preferred to a π and other times the other way about. If a very wide range is needed, it is better to use several stages. The Fig. 8 system is ideal from this point of view, and is convenient for setting up a particular amount of attenuation required, but not where a lot of adjustment is to be done.

Attenuators as Transformers

So far we have been assuming the necessity, or at least the desirability, of having equal input and output resistances. In the one example we considered of a generator feeding a load of a different impedance—the valve and loudspeaker—the step-down was done by a transformer, so that whether an attenuator were put in the primary or secondary side it would be working between equal impedances. It may not be realized by everyone that the attenuator itself can be designed to serve also as the transformer. If the Fig. 6 type were used, and the series resistor were made 5,000 Ω (or about 1¼ Ω less, to be precise!) and the shunt resistor were made 2½ Ω (or a shade over), the valve would see a load of 5,000 Ω and the loudspeaker

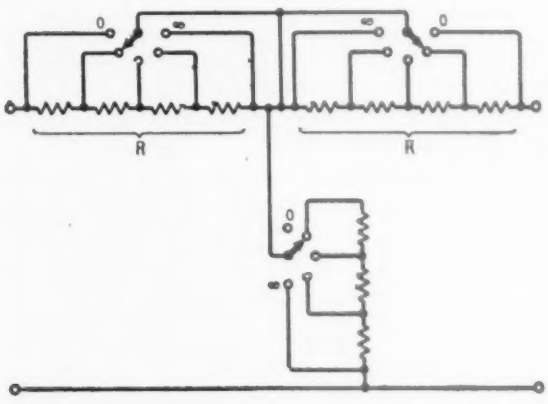


Fig. 7. The tapped-resistor method of controlling the attenuation of the T type unit.

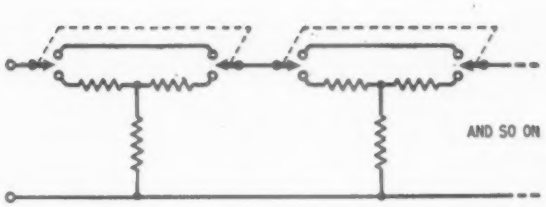


Fig. 8. In this method of controlling attenuation, fixed T units are switched in or out.

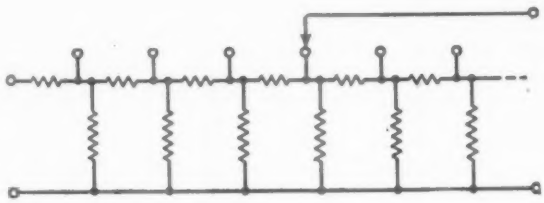


Fig. 9. This tapped ladder attenuator is much easier to make than Figs. 7 or 8, but does not give perfect matching.

would see a source of 2½ Ω, so as regards impedance-matching nobody could find fault with the arrangement, and it would certainly cost much less than a transformer. There would of course be the trifling practical objection that the h.t. supply to the valve would encounter a resistance of 5,000 Ω in place of the customary transformer winding; even if one were prepared to put up with that there might be some dissatisfaction owing to the *minimum* available attenuation being 39 db! The fact that one could arrange to vary it as much as desired beyond this figure would probably be small compensation for such an initial loss.

But that was rather an absurdly extreme example. With smaller resistance ratios the minimum loss is less: for matching a 2 : 1 ratio it is 7½ db; for 3 : 1, 10 db; and so on. It is always decidedly greater than the loss resulting from direct connection (Fig. 3); the difference is the price paid for matching, which sometimes has important advantages apart from the question of power loss. The loss due to connecting the speaker direct to the valve, assuming that 5,000 Ω was the internal resistance of the valve as well as its optimum load resistance, would be 33 db—6 db less than with the matching pad—but the distortion would almost certainly be much greater. So if one did come across a need for matching two unequal resistances and at the same time introducing some attenuation, the ability of a simple pad to do both at once might be worth knowing.

One result of the input and output impedances being dependent on what is connected at the other end is that if it is necessary to match a unit having an output at say 600 Ω it is not enough to design the attenuator (or whatever is connected to it) to have an input of 600 Ω. This can only be a kind of conditional promise that it will be 600 Ω, subject to the co-operation of third or even fourth, etc., parties. It is like a firm's estimate bearing a footnote to the effect that it is subject to market fluctuations in the prices of materials and so on. In other words, the estimator is not wholly responsible for what he charges; he may have to pay a lot of what he gets from you to someone else, just as the attenuator has to pass on some of what it receives from the generator

to the load, the actual amount depending on the load's impedance. The extreme case is when the attenuation is zero, for then the input impedance of the attenuator is identical with the input impedance of the load. The greater the attenuation, the less what is connected at one end effects what is connected at the other. So in places where it can be arranged that there is always a fair amount of attenuation, it can also be ensured that one end is always quite well matched even though the impedance at the other end varies widely. Of course the departure from designed impedance causes an extra loss at that end; the amount can be found from Fig. 3.

An example of this sort of thing is the connection between a television aerial and the receiver. If the feeder is long, or exceptionally lossy, or has a matched attenuator between it and the receiver, then if the feeder itself is the right impedance for the aerial it makes little difference to the matching at the aerial end whether the receiver is a good match or not.

In case anyone wants to make an attenuator with equal input and output resistance (R) without having to look up the formulæ elsewhere, or having to work them out from first principles—which is a not very difficult exercise on Ohm's law—here they are for the T and π types. If N is the ratio of input to output voltage or current (square root of input to output power), then for the T type:

$$R_s = R\left(\frac{N-1}{N+1}\right)$$

$$R_p = R\left(\frac{2N}{N^2-1}\right)$$

The π type is the dual of the T type (for what this means see April 1952 issue) so the formulæ are the same except for conductance taking the place of resistance and series taking the place of parallel. The resistances are therefore:

$$R_s = R\left(\frac{N^2-1}{2N}\right)$$

$$R_p = R\left(\frac{N+1}{N-1}\right)$$

As an example, suppose the required attenuation is 10 db, which is a 10 : 1 power reduction, so $N = \sqrt{10} = 3.16$. Then for the T type $R_s = 0.52$ R and $R_p = 0.70$R, and for the π type $R_s = 1.42$R and $R_p = 1.92$R. Usually the T type is preferred, because it requires lower resistances.

Last Month's Problem

While we are busy with examples, here is the answer to last month's. You remember there was a parallel tuned circuit with resistance in each branch, and the problem was to find the frequency of resonance, this being defined as the frequency at which current would be in phase with applied voltage. In other words, the reactance of the circuit as a whole is zero. This circuit is covered by the formidable-looking equation that was given, but there is no need to cope with the whole of this; all we have to do is to find the condition that makes the part controlled by j disappear—for that is the reactance part. So we write

$$X_1X_2(X_1 + X_2) + R_1^2X_2 + R_2^2X_1 = 0$$

In this particular case $X_1 = \omega L$ and $X_2 = -1/\omega C$, ω being as usual the shorthand for $2\pi f$. So we have

$$-\frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right) - \frac{R_1^2}{\omega C} + R_2^2\omega L = 0$$

Multiplying both sides by ω,

$$-\frac{\omega^2L^2}{C} + \frac{L}{C^2} - \frac{R_1^2}{C} + R_2^2\,\omega^2L = 0$$

$$\omega^2\left(R_2^2L - \frac{L^2}{C}\right) = \frac{R_1^2}{C} - \frac{L}{C^2}$$

$$\omega^2 = \left(\frac{R_1^2}{C} - \frac{L}{C^2}\right) \Big/ \left(R_2^2L - \frac{L^2}{C}\right)$$

$$f = \frac{1}{2\pi\sqrt{LC}} \cdot \sqrt{\frac{L - R_1^2C}{L - R_2^2C}}$$

The first term is the well-known expression for the resonant frequency of a series tuned circuit, or for a parallel circuit neglecting resistance; the second is a correction factor which has no effect if R_1 and R_2 are either zero or equal to one another. Usually R_2 can be neglected but not R_1, in which case the thing reduces to

$$\omega^2 = \frac{1}{LC} - \frac{R_1^2}{L^2}$$

which we came across in the January 1953 issue, on resonance curves.

RADAR ON ICE

Detection of Bergs and "Growlers"

THE value, and, too, the limitations, of radar as an aid to navigation in ice-infested waters were recently confirmed as a result of a 5,000-mile voyage in the Belle Isle and Hudson Straits by the ice breaker *N.B. McLean* fitted with Type 268 Naval radar equipment.

Investigations have previously been undertaken, but these were inconclusive in that the published reports did not give measurements of the actual radar response of ice targets. In order to obtain fuller information three investigators—two from the Ministry of Transport and one from the National Research Council of Canada—sailed in the ice breaker for two months last summer.

In the paper "Radar and Ice," recently presented to members of the Institute of Navigation, L. S. Le Page, who is in charge of the Radar Operational Research Group (M.o.T.), and A. L. P. Milwright, a senior experimental officer at the Admiralty Signal and Radar Establishment, summarized the findings. They stated that in calm weather, which is usual in fog, ice formations of all types can be detected—from large bergs at 20 miles, down to small "growlers" at 1½ miles. The latter, which are smoothly rounded pieces of ice protruding up to 10ft out of the sea and weighing several hundred tons, however, are unlikely to be detected at ranges exceeding three miles. The authors emphasize that for a ship travelling at 15 knots this represents a warning period of only 12 minutes, and it is obvious, therefore, that a continuous radar watch must be kept

when navigating in waters where ice is to be expected. With rough seas and bad visibility, when sea clutter on the p.p.i. may extend beyond one mile, it is unsafe to rely upon radar navigation, as growlers may not be detected.

Fields of tight pack-ice composed of hummock ice can, it is stated, be detected under all sea conditions up to ranges of approximately three miles, as can "leads" through the ice of over 200 yards width.

A great deal of summer ice of all types was observed during the voyage, from soft pack-ice to bergs up to 200ft high. These were recorded photographically and detailed radar measurements were carried out on some 60 ice formations. The results of these investigations (which, incidentally, provided no proof that atmospheric conditions reduce detection ranges), and recommendations for improving the performance of marine radar gear for ice detection are given in the paper which will be published in full in the *Journal of the Institute of Navigation.*

Time by Telearchics

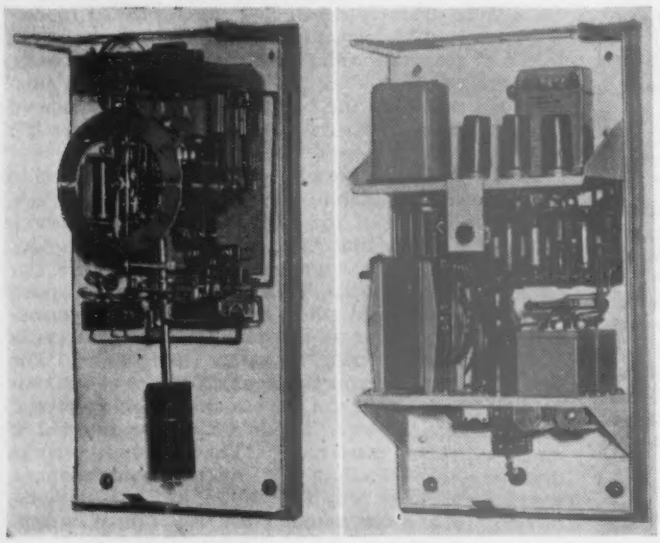
Experimental Radio-Controlled Clock

CONSIDERING the number of years people have been in the habit of setting their clocks by radio time signals, one would have thought some system could have been devised for using such signals for the automatic control of clocks. It seems such a simple and obvious step to take. Actually a good many experimenters have toyed with the idea, but have had to give it up—probably through the lack of a sufficiently regular and reliable service of signals.

This year, however, the idea may become rather more of a practical proposition, for we understand that the National Physical Laboratory is hoping to broadcast from Rugby a regular 24-hour service of standard frequencies, including pulses of 1-kc/s tone at one-second intervals. This will be an extension of the present restricted service from Rugby (see note on page 119). The pulses will be radiated for a period of 5 minutes in each 15-minute transmission cycle, as at present, throughout the day. They will be generated locally at Rugby but will be monitored by the Royal Observatory station at Abinger and periodically corrected so as to be as nearly as possible in step with astronomical time. The discrepancy may amount to about 50 milliseconds at the worst. Thus, although the pulses are really intended as a standard frequency, they will, in fact, provide a very accurate time service.

To make use of this proposed new service, an experimental radio-controlled clock has already been built by S. J. Smith* and J. K. Langham*, and was demonstrated recently to the British Horological Institute. It is a conventional pendulum clock in which the pendulum is kept in step with the pulses by means of an electromagnetically-operated pawl. This pawl strikes a vertical piece of spring steel on the pendulum and bends it either one way or the other, depending on whether the pendulum is in advance or retard. The energy stored in the bent spring then serves to accelerate or slow down the pendulum so that the error is corrected.

The pendulum clock is on the left and the electronic apparatus is in the unit on the right. The pendulum of the clock maintains a good time standard of its own accord and will thus cover short breakdowns in transmission.



On the electronic side the main problem is that the pulses from the receiver are of too short a duration (5 milliseconds) to operate the electromagnet properly as they stand. It has therefore been necessary to "stretch" them to 80 milliseconds by means of a storage capacitor. As a result of this operation they lose some of their sharpness, so they have to be put through a squaring device (a flip-flop circuit) to make them sufficiently sharp to give the necessary rapid operation of the electromagnet. Actually, only the first and last pulses of the 5-minute period are used. The remainder are cut out by a time switch operated by the clock, which also serves to eliminate the rest of the 15-minute transmission cycle.

The clock has been tried out on an experimental transmission on 2½ Mc/s, and it is claimed to behave very well in areas of reasonable signal strength. Unfortunately, however, the transmitter does not give complete coverage of the British Isles (in London the signal is particularly bad), and this rather limits the application of the system.

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Flywheel Synchronization

Avoiding Line Jitter in Television Fringe Areas

By B. T. GILLING

THE noise content of the vision signal in fringe areas degrades the picture in two ways. First, it superimposes a grain on the actual picture, and secondly it mutilates the line sync pulses, causing the line time-base to fire in a random manner around the pulse and not at its leading edge. This second effect is by far the more serious as the irregular displacement of lines causes what is in effect serious horizontal defocusing. Any method of locking the time base directly from the sync pulses will suffer from this defect.

A way of overcoming this trouble is the utilization of flywheel synchronizing, or, as it is known in America, automatic frequency control. In this system, the frequencies of the sawtooth output from the line time-base and of the incoming sync pulses are compared in a discriminator circuit. A resultant output voltage is obtained whose polarity and amplitude are dependent on the frequency difference of the two input frequencies. This voltage is passed through a fairly long time-constant RC filter to average out the irregularities and then used to control the frequency of the sawtooth generator. Thus, the line time-base is no longer controlled by each individual line sync pulse but by the average of a large number.

The most noticeable improvement seen when flywheel sync is used is on the verticals. The three sketches in Fig. 1 illustrate this; (a) is an ideal vertical line, and (b) and (c) the same line as seen in fringe areas with considerable noise present. The first is with normal direct synchronizing and the second using flywheel sync. The difference between the two latter lines is self-evident. With direct synchronizing the line is broadened and blurred, whereas with flywheel sync, although at times of very severe noise the line may be slightly curved and waving, it is definite, clear and of the correct width.

There are several methods of flywheel synchronizing, some of which are fairly complex and require specially designed transformers, but the system to be described in this article is simple and calls for the use of no specialized components. It is so easily applied to existing sets and so simple to get to work that, when one considers the enormous improvement in picture quality obtained with it, it is a matter of real surprise that it is almost never used in this country in sets designed for fringe area reception.

The basic circuit of the frequency discriminator is shown in Fig. 2. Negative-going sync pulses from the normal sync separator are fed to the grid of V_1 and appear at its anode and cathode in opposite phase. The positive pulse at the anode makes the diode $V_{2(a)}$ conduct to earth through R_5 and similarly the negative pulse at the cathode causes $V_{2(b)}$ to conduct to earth also through R_5. The pulses pass the outer ends of the joined resistors R_3, R_4 at the same instant and, since these pulses are equal and opposite, there will be no potential difference between point "A" and earth. A small portion of the sawtooth from the anode of the line output valve is applied to the joined anode and cathode of the two diodes. As the diodes conduct only at the time of the sync pulses, this is the only time that the sawtooth will be able to affect the circuit, and this occurs only during the flyback period.

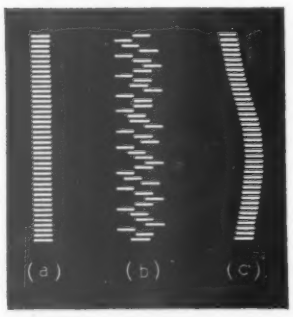


Fig. 1. Appearance of a vertical line on the screen : (a) ideal vertical line, (b) with normal synchronization in fringe areas (c) with flywheel sync.

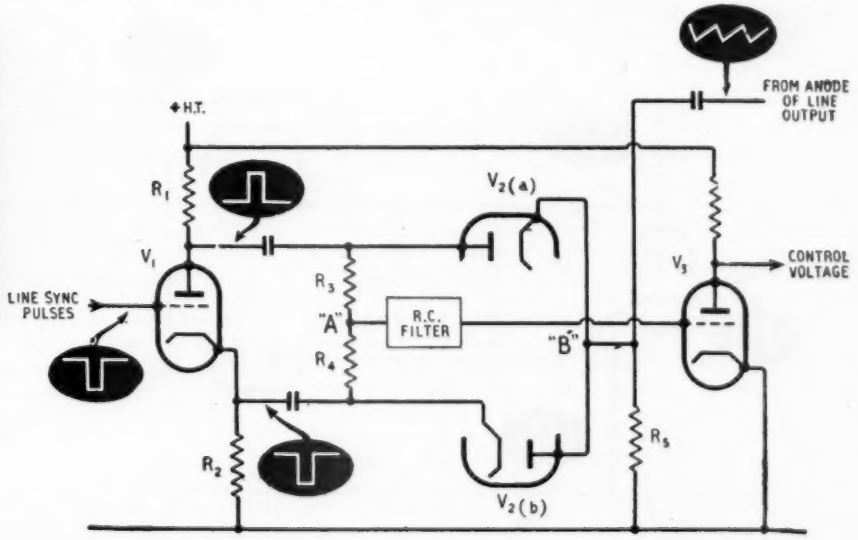


Fig. 2. Basic circuit of frequency discriminator.

This will give rise to three situations which must be examined in detail.

Before dealing with these three states we must examine the relationships between the incoming sync pulses and the sawtooth. The sawtooth applied to the grid of the line output valve has its flyback going from positive to negative, therefore at the anode the flyback goes from negative to positive. When this sawtooth reaches point "B" in Fig. 2 it has lost its peaks and is of the shape shown in Fig. 3(b). Fig. 3 shows graphically the three conditions met with, all drawn on the same horizontal time scale, (a) representing the sync pulses as they reach "B." In 3(b) the sawtooth is of the exact frequency of the pulses. In 3(c) the time base is running too fast and the flyback has passed its zero position and reached a positive potential at the time of the arrival of the pulse. In 3(d) the opposite is the case. The time base is slow and the flyback is still negative when the pulse arrives.

The effect these three conditions have on the discriminator must now be examined. The first condition is when the flyback is passing through its zero position at the moment of arrival of the pulse (b). This will cause no disturbance at point "B" and the zero potential difference between "A" and earth will remain unchanged. This is the ideal state of affairs, the incoming pulses and the sawtooth being in synchrony.

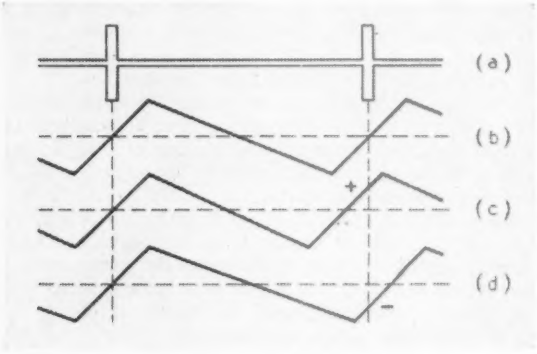
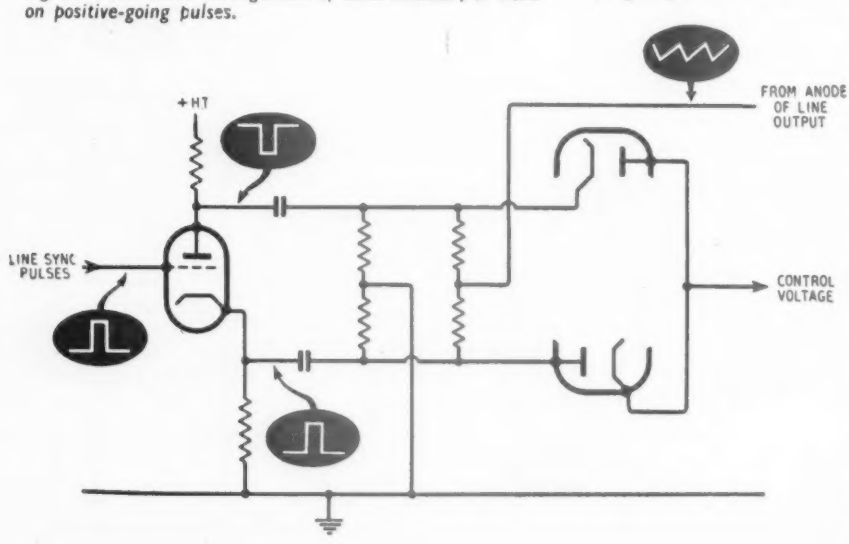


Fig. 3. Relationships between incoming sync pulses and sawtooth at anode of line output pentode.

Fig. 4. Alternative arrangement of discriminator, to work on positive-going pulses.



The second state is when the time base is running slightly too fast and therefore the flyback is positive at the moment of arrival of the pulse [Fig. 3(c)]. The positive flyback potential appears equally at the cathode of $V_{2(a)}$ and the anode of $V_{2(b)}$ causing $V_{2(a)}$ to conduct the positive pulse from the anode of V_1 less well and $V_{2(b)}$ to conduct the negative pulse from the cathode better. Thus the anode of $V_{2(a)}$ becomes more positive and the cathode of $V_{2(b)}$ less negative and point "A" becomes positive relative to earth. After being passed through a fairly long time-constant RC filter the postive voltage from "A" is applied to the grid of V_3, a d.c. amplifier, causing its anode current to increase and the voltage at its anode to move negative. If this anode is connected in some way to the control point of the sawtooth generator the change to a more negative voltage will reduce the generator's frequency, pulling it into step with the incoming sync pulses.

The third state is when the sawtooth is slower than the sync pulses [Fig. 3(d)]. In this case the pulse will arrive at "B" when the flyback is negative and circuit conditions will be the reverse of the second state. $V_{2(a)}$ will conduct more, $V_{2(b)}$ less, and a potential negative to earth will appear at "A." This, when applied to the grid of V_3, will make the anode go more positive and the frequency of the generator will be increased.

There are many variations of this basic discriminator circuit. One of these is shown in Fig. 4 arranged to work on a positive-going sync pulse. Its operation is essentially the same as Fig. 2.

A detailed circuit for practical application is shown in Fig. 5. It is very easy to get going and after the theoretical considerations above few operational notes are necessary. The pairs of resistors R_{3-5} and R_{6-7}, must be either matched or of close tolerance. Special attention must be given to the 680-kΩ resistor R_{10}. This is connected to the anode of the line output pentode where very high peak voltages appear. A single resistor is not advisable: the value should be made up of two one-watt resistors connected in series and so placed that their insulation to earth is high. It may well be found that the discriminator will work with a higher value of R_{10}, depending on the type of line output stage used. The highest value consistent with satisfactory operation should be used. A resistor of up to 2,000Ω in the cathode lead of $V_{1(b)}$ will sometimes improve operation but should not be needed. With regard to valves, any double diode with separate cathodes can be used and a 6SN7 is quite satisfactory for the triodes.

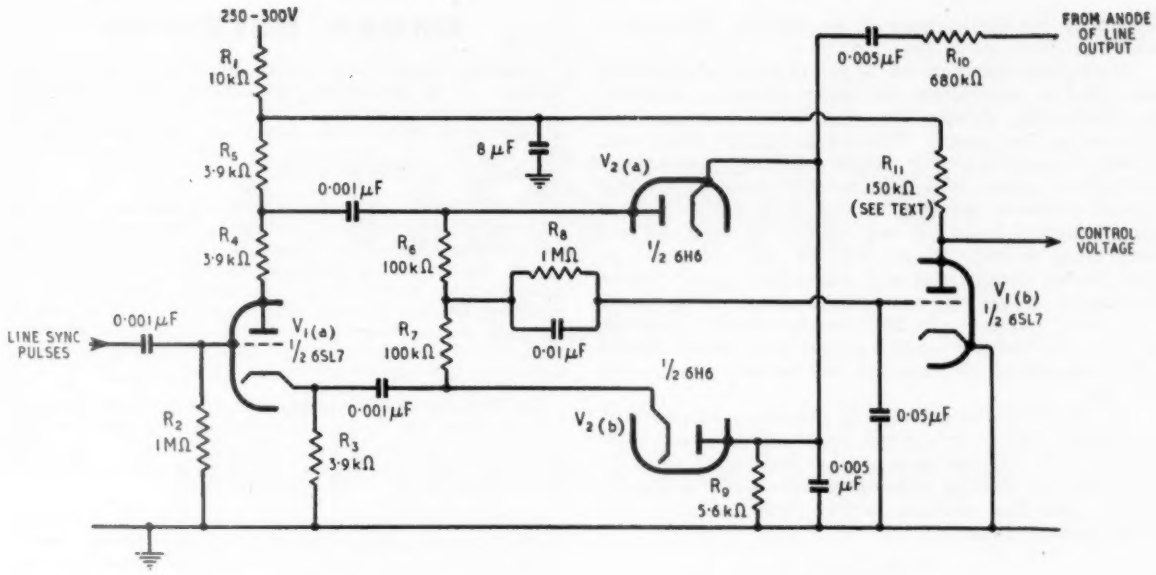
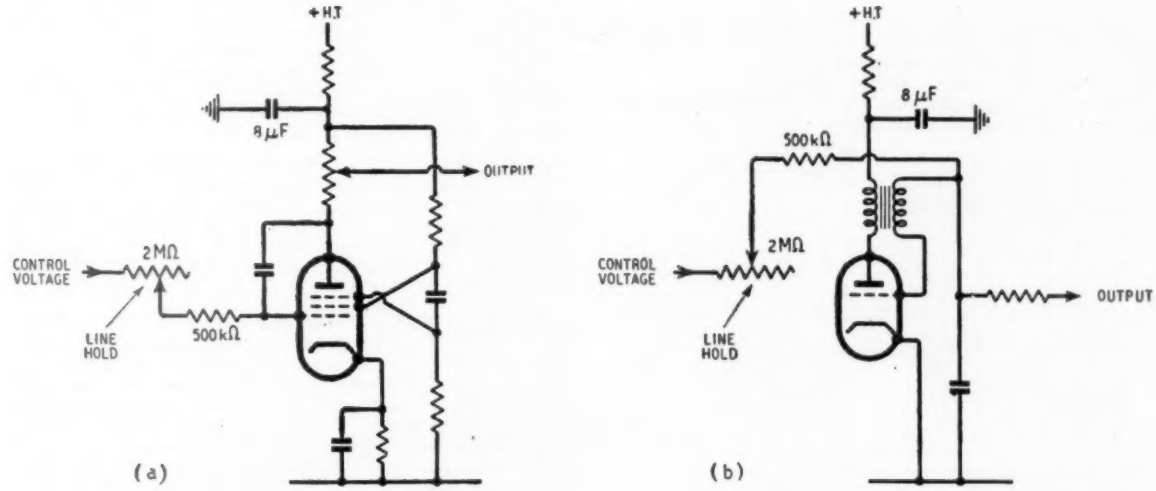


Fig. 5. Complete circuit diagram of frequency discriminator and d.c. amplifier for negative-going sync pulses.

Fig. 6. (a) Control applied to transitron sawtooth generator as in the Wireless World *television receiver. (b) Control applied to a blocking oscillator sawtooth generator.*



Line time-bases are almost always either transitrons, blocking oscillators or multivibrators, and line hold is usually controlled either by a variable high resistor taken to +h.t. or by a potentiometer across the h.t. supply. To control the time-base by the discriminator output voltage the two methods are combined. The high-value variable resistor is used as a manual hold control and, instead of being taken to +h.t., it is connected to the anode of the d.c. amplifier. This valve and its load resistor (Fig. 5 $V_{1(b)}$, R_{11}) form a potentiometer across the h.t. supply and since the voltage at the anode is controlled by the discriminator the frequency of the time-base will be pulled into step with the sync pulses. The actual value of R_{11} must be found experimentally. When the circuit is being put into operation a variable resistor of about 500 kΩ must be substituted. With the manual line-hold control at about its mid position, adjust the variable resistor until the picture locks. The variable resistor is then measured and the same value wired into circuit. The minimum value of this resistor is about 50 kΩ. Anything lower will reduce the efficiency of the control.

Two representative time-base circuits are given in Fig. 6. The first is a transitron as used in the *Wireless World* receiver and the second a blocking oscillator. The control is indicated in each. The setting of the line hold moves the picture slightly across the screen. In the writer's set the total movement is about half an inch on a twelve-inch screen. It is important that this control be set so that the picture is correctly centred, otherwise there is a

tendency for the picture to be slightly distorted at the top.

A receiver based on the *Wireless World* design was modified to incorporate the above system of flywheel synchronizing shortly after the Wenvoe transmitter opened on low power. The set is situated about one hundred miles from the station and the improvement in picture quality was remarkable. Even on a weak signal, lettering on the screen could be read with ease, whereas before it was impossible to make out individual words. Since Wenvoe has increased to full power, comparison with other sets in the neighbourhood makes the worthwhile-nature of flywheel sync very evident. In fact, in the writer's opinion, any set, in however good a signal area, which shows any raggedness of verticals will benefit greatly by its use.

A very complete account of the many methods of automatic frequency control appeared in a series of articles in the American magazine *Radio & Television News* for the months of January, February and March, 1950, and the present writer acknowledges his indebtedness to these.

Short-wave Conditions

Predictions for March

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during March.

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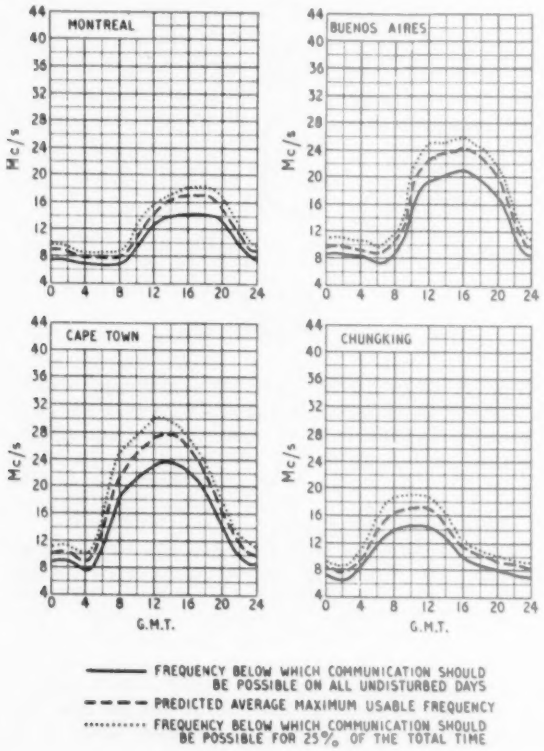
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Electrical Units (with special reference to the M.K.S. system) by E. Bradshaw, M.Sc.Tech., Ph.D., M.I.E.E. Comparative assessment of the characteristics of systems of electrical units, with tables of conversion factors. Pp. 64; Figs. 9. Chapman & Hall, 37, Essex Street, London, W.C.2. Price 9s 6d.

World Radio Handbook for Listeners (Seventh edition). Edited by Lund Johansen. Data on the principal broadcasting stations of the world, including interval signals and times of transmission. Pp. 124 with many illustrations. *World Radio Handbook*, Lindorffsalle 1, Hellerup, Denmark. Price 8.50 Danish Kr., $1.50 or 8s 6d (postage extra). Supplies in Gt. Britain may be obtained from Wm. Dawson and Sons, Ltd., Cannon House, Macklin Street, London, W.C.2, by post at 9s.

La Pratique des Magnétophones by P. Hemardinquer. Construction, adjustment, fault-finding, maintenance and applications of magnetic recording equipment. Pp. 180; Figs. 95. Editions Chiron, 40, Rue de Seine, Paris 6. Price 870fr.

Leitfaden der Funkortung (Guide to Radio Location) by W. Stanner (and co-workers). Comprehensive survey of direction finding, radar, hyperbolic chain systems, etc., including a chapter on radio astronomy. Pp. 163; Figs. 85. Electron-Verlag, Maxstadtstrasse, 1, Garmisch-Partenkirchen, Germany. Price 12 DM.

Temperature and Humidity Gradients in the First 100m Over South-East England, by A. C. Best, M.Sc., E. Knighting, B.Sc., R. H. Pedlow, B.Sc., and K. Stormonth, B.Sc. Analysis of data, of importance in the propagation of radio and radar signals, collected over a period of three years, giving the mean variation of temperature and humidity at different heights, and of the lapse rate of these quantities for each month. Maximum values, and the frequency of occurence of other magnitudes of the lapse rates of temperature and humidity are included. Pp. 60, Figs. 18. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 7s 6d.

Measurements at Centimeter Wavelength by Donald D. King. Survey of theoretical principles and practical methods of measurement, including chapters on generators, detectors, the measurement of impedance and of radiation. Pp. 327+vii; Figs. 219. D. van Nostrand Company and Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 42s.

Radio and Radar Technique by A. T. Starr, M.A., Ph.D., M.I.E.E. Written for readers, with basic knowledge of university degree standard, who require in one volume a comprehensive digest of the post-war literature on communication and radar techniques. Special emphasis is given to the role of noise in electronic systems, fundamental behaviour of special valves, microwave techniques and pulse waveforms. Pp. 812+xvii; Figs. 488. Sir Isaac Pitman & Sons, Ltd., Parker Street, London, W.C.2. Price 75s.

Radio Upkeep and Repairs by Alfred T. Witts, A.M.I.E.E. Revised seventh edition of this handbook on servicing principles and receiver maintenance. Pp. 220+iv; Figs. 159. Sir Isaac Pitman & Sons, Ltd., Parker Street, London, W.C.2. Price 12s 6d.

Home Mechanic's TV Servicing by William R. Wellman and Joseph J. Kadrle. Written from the point of view of American requirements and contains many hints and tips of general utility. Pp. 159+viii; Figs. 66. D. van Nostrand Company and Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 21s.

Electricity in the Home by C. B. Brook, A.M.I.E.E. Primarily written for domestic appliance users and car owners, with advice on maintenance and elementary fault-finding and repairs. Pp. 204; Figs. 86. Advertiser Press, Ltd., Page Street, Huddersfield. Price 6s 6d.

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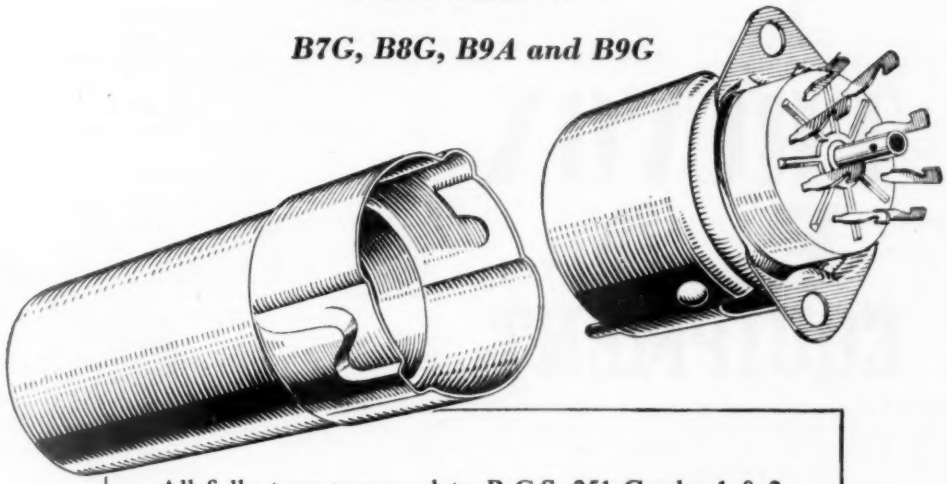

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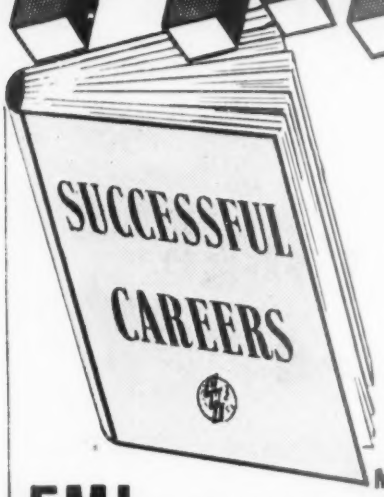

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Calibrating V.H.F. Oscillators

Method Requiring Only Two Known Frequencies in Each Range

By M. C. MATTHEWS

THE writer recently constructed a grid-dip oscillator covering the band 40–60 Mc/s for use in testing and adjusting television sets and, having completed it, was faced with the problem of calibration. The usual method of beating the oscillator against a standard signal generator was not possible as no such instrument was available. Various possibilities were considered, and eventually examination of the tuning capacitor suggested the procedure which follows.

The success of the method depends on the fact that the usual pattern of high frequency tuning capacitor of the order of 50 pF maximum capacitance having semi-circular plates has, once the fixed and moving plates are partly meshed, a linear relationship between rotation and capacitance. This being the case it is only necessary to determine accurately two points on the scale in order to be able to calculate the remainder.

The method is perhaps best explained by describing the procedure used in the case of the writer's instrument. This is fitted with a drive scaled 0–180 and arranged so that scale reading increases with capacitance.

It is first necessary to determine the two reference points, and this was done by beating the oscillator first against the sound carrier on 41.5 Mc/s and then, with a pair of phones on the detector, against the vision carrier on 45 Mc/s. In this particular case it was required that the sound frequency should fall near one end of the scale, so the inductance of the coil was adjusted until it fell at 155, at which point the capacitor vanes were adequately meshed. The vision carrier then fell at 112.

The mathematics of the formula used are simple and are adequately covered in the Appendix, and it is only necessary here to say that we now proceed to substitute in the equation $D + C_1 = \frac{K}{f^2}$, where D = dial reading, C_1 = a constant proportional to the minimum and stray capacitances, K = a constant and f = the operating frequency in Mc/s.

The first step is to determine the two constants K and C thus :—

Inserting the known values for the reference points we have

$$155 + C_1 = \frac{K}{1{,}722} \quad .. \quad .. \quad .. \quad (1)$$

$$112 + C_1 = \frac{K}{2{,}025} \quad .. \quad .. \quad .. \quad (2)$$

Subtracting (2) from (1) we get

$$155 - 112 = \frac{K}{1{,}722} - \frac{K}{2{,}025}$$

$$\therefore \quad 43 = \frac{303K}{3{,}487{,}000}$$

$$\therefore \quad K = 495{,}000$$

Substituting for K in (1) we get

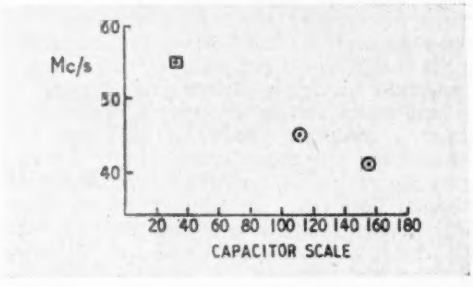
$$155 + C_1 = \frac{495{,}000}{1{,}722}$$

$$\therefore \quad C_1 = 132$$

Having determined C_1 and K the rest is simple arithmetic. It is best to set out a table as shown below.

It must be repeated that it is not safe to extend these calculations to within less than about 20 deg of the limits of travel of the moving plates. If the drive is arranged so that the reading varies inversely with capacitance it is only necessary to commence by subtracting the dial readings of the reference points from the full scale reading in order to obtain a figure which varies directly with capacitance. After the calculations are complete the figures in column 4 of

How a calibration curve is obtained from two known points only. These are the encircled ones while a calculated point is shown in a square.



TABLE

1 f (Mc/s)	2 f^2	3 $\frac{K}{f^2}$	4 (3) − C_1
41.5	1,722	287	155
42.0	1,765	280	148
42.5	1,810	274	142
43.0	1,852	267	135
43.5	1,895	261	129
44.0	1,940	255	123
etc.			

the table must then be deducted from the full scale reading in order to obtain true dial readings.

The method has obvious limitations, but in suitable cases it provides a simple and accurate method of calibration.

APPENDIX

The procedure described above is based on the equation $f = \frac{K_1}{\sqrt{LC}}$, where f = resonant frequency, K_1 = a constant, L = inductance in circuit and C = total capacitance in circuit.

In the present case L is a constant as well as K_1 and we can therefore rearrange the equation thus :—

$$C = \frac{K_1^2}{f^2 L}$$

$$= \frac{K_2}{f^2} \text{ where } K_2 = \frac{K_1^2}{L}$$

Now the dial reading D is proportional to the capacitance of the tuning capacitor if a constant C_1 is added, this constant being proportional to the minimum capacitance of the circuit. We therefore have

$$C = (D + C_1)K_3$$

Substituting this for C in the first equation we get

$$(D + C_1)K_3 = \frac{K_2}{f^2}$$

and therefore $D + C_1 = \frac{K}{f^2}$ where $K = \frac{K_2}{K_3}$.

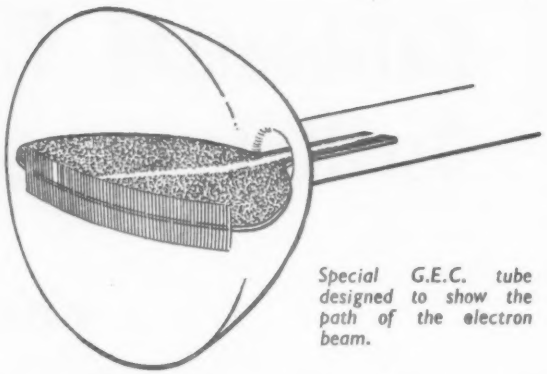
TELEVISION SOCIETY'S EXHIBITION

THE Television Society's annual exhibition of equipment related to television design and production was held in London on January 23rd and 24th; there were 35 exhibitors. A feature of the exhibition was its dynamic character, for an unusually large number of the exhibits were demonstrations of an instructional nature.

E. K. Cole, for instance, showed two identical receivers working side by side, one having spot-wobble in operation and the other without it. Line broadening without spot-wobble was demonstrated by T. Kilvington of the Post Office Research Department, who showed a receiver in which the scanning spot is deformed to a short vertical line by two small pieces of magnetic material placed diametrically opposite one another in the gap of the focus magnet.

The shape and path of the electron beam in a c.r. tube were made visible by L. S. Allard of the G.E.C. Research Laboratories, who showed a special tube having a plate coated with fluorescent material and lying on the axis of the tube, its shape fitting the inside contours. The beam is given a small vertical deflection to avoid the need for accurate alignment, and this produces a vertical line on a narrow band of fluorescent material on the face of the tube. The whole path and shape of the beam can be seen from inside the deflector coils to the screen, and the effect of focusing and deflection upon the beam can be studied in detail.

Ediswan showed a tube having only part of its screen aluminized, operating with a raster to illustrate the effect of aluminizing, and another tube with a layer of liquid outside the screen to show how a suitable material can remove "halo."



Special G.E.C. tube designed to show the path of the electron beam.

The effect of flywheel synchronizing in reducing the effect of noise and interference upon line synchronizing was well brought out by the Ferguson exhibit. This comprised a receiver arranged to switch from one form of synchronizing to the other and operating with a local source of interference superimposed on the television signal.

Flywheel sync was also used in the apparatus shown in operation by Murphy Radio. This comprised a modified V204 receiver chassis operating a 24-in c.r. tube working at 18 kV. Other large-screen directly viewed sets were shown, including the 17-in Alba a.c./d.c. model in which the e.h.t. supply is 17.5 kV.

Projection models were also there in numbers and use the Mullard 2½-in tube with 25 kV e.h.t. and the Schmidt optical system. The Ferranti set is unusual in having a push-pull video stage, while the Nera sets depart from convention in being of the front-projection type. The model C30 is an especially neat set in that it is self-contained, the screen hinging upwards and the projector pulling out from the front for use. The Decca set giving a 4-ft by 3-ft picture is also of the front-projection type.

Mullard showed a range of c.r. tubes, including the MW36-24, having rectangular screen of 14-in diagonal and a grey face, while Cinema-Television showed a projection tube for producing the very large picture needed for the cinema. Oscilloscope tubes appeared in the display by 20th Century Electronics.

Test equipment formed a substantial section of the exhibition. One item was a television field-strength measuring set shown by Belling & Lee. The carrier of the sound signal is used to operate a meter to show the level of this signal and the video signal is displayed on a c.r. tube, the amplitude of the frame sync pulses being used as a measure of signal strength. By having this visual display the effect of "ghost" signals can be observed.

Philips Electrical utilized their Composite Pattern Generator to provide one source of signals for distribution around the exhibition, the other sources being the B.B.C. and a camera in the exhibition room. Telequipment showed a pattern generator and monoscope equipment for factory use, while Bush Radio displayed a generator producing 525- and 625-line signals with negative modulation and f.m. sound. This is for testing apparatus designed for the American and Continental standards. In addition to providing test patterns, it can accept live signals derived from the B.B.C. 45-Mc/s vision signal and the 90-Mc/s f.m. signal from Wrotham.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Moulded Nylon

NYLON is best known as a textile material, but it is now beginning to figure in various branches of mechanical and electrical engineering as plastic mouldings of one kind or another. It is a thermo-setting plastic and may be re-heated and re-shaped many times without greatly affecting its physical properties.

Most thermo-setting plastics soften in the region of 180 deg F but nylon will remain hard up to 300 deg F, its melting temperature being about 480 deg F.

In view of its heat-resisting qualities it is interesting to speculate on its potential usefulness as a radio insulator. Its electrical insulation properties are good and comparable with many other moulded insulators and it has some definite advantages on the score of mechanical strength.

The dielectric constant of moulded nylon at 1 Mc/s is given as 3.4, its dielectric strength (short time) as 385 V/mil and the power factor as 0.04. Whilst its radio uses may, for the time being, be limited to the lower frequencies it nevertheless has many applications where high mechanical strength without undue bulk and weight and heat-resisting qualities have an overriding influence. Certain kinds of coil formers come to mind where soldering is required to integral tags and contacts without risk of the material softening.

British Ropes, Ltd., have for some time past specialized in the production of nylon mouldings in their Leith, Edinburgh, factory and they are prepared to investigate new applications for the material.

Miniature Signal Lamp

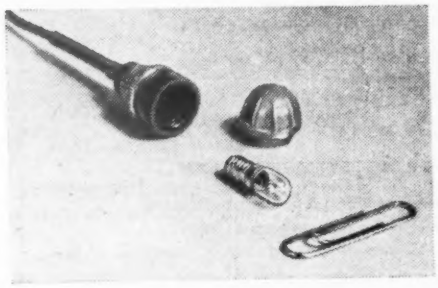
A LILLIPUTIAN signal lamp fitting moulded in a material which is both tough and moisture resisting forms the latest addition to the range of signal lamps made by A. F. Bulgin and Co., Ltd., Bye-Pass Road, Barking, Essex. Some idea of its small size can be judged by the following dimensions: overall diameter just over $\frac{1}{2}$ in and overall depth, back to front, $1\frac{1}{4}$ in. It is single-hole fixing and needs a $\frac{3}{8}$-in diameter hole. Provision is made for fitting to panels up to just under $\frac{1}{8}$ in thick.

The fitting is in two parts, a black moulded body containing the miniature screw-type lamp holder, which incidentally measures only $\frac{3}{16}$ in in diameter, and a screw-in domed-shaped lens made of a transluscent material and available in red, amber, green, blue and white.

This tiny indicator lamp should find many applications in miniature apparatus and wherever space is very restricted. Despite its small size it throws quite a wide angle beam of light. As the fitting is too small to take any kind of tags or connecting lugs two different coloured insulated wires are brought out from the back and protected where they emerge from the body of the fitting by a flexible rubber sleeve.

Special small lamps only can be used and either the Hivac miniature with lilliput screw cap or an equivalent made by Vitality Bulbs will fit it. The maximum working voltage is 24, but normally lamps of 4 to 6 volts will be used.

Bulgin miniature moulded signal lamp fitting Type D675 available in five different colours.



"Anti-Tracking" Grease

THE water-repellent properties of silicone compounds, their good dielectric properties and the stability of their physical properties under extreme climatic conditions have been exploited in the formulation of special greases for weather proofing the ignition systems of aircraft and vehicles. Developed originally in America by the Dow Corning Corporation, silicone compound DC4, as it is called, is proving useful in the manufacture and servicing of television receivers, where it is applied as a surface treatment to maintain resistivity in e.h.t. circuits. Points where it is most effective include the area of glass adjacent to the anode cap of the c.r. tube, and the ends of e.h.t. rectifiers after soldering the connection.

Supplies are now available in this country, in 2-oz collapsible tubes with nozzle, from Direct T/V Replacements, 134-136, Lewisham Way, New Cross, London, S.E.14; the price is 10s or 10s 6d by post.

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RANDOM RADIATIONS

By "DIALLIST"

It's Easy, or Is It?

I BOUGHT a couple of 3-pin 5-amp switched sockets a short time ago with the firm intention of purging the wiring system of my house of its last remaining 2-pin sockets. I had fortunately not found time to do this when the switch of the three-pin socket from which the domestic receiver derives its power recently failed. With two spares to choose from, I thought the job of getting the wireless set going again wouldn't take a jiffy. No need to switch off the lights, for the circuit had its own fuses on the mains side of the socket. It was *easy* . . . or was it? Read on.

The Master Touch

Every now and then, I think, some designer of the bits and pieces that we use arrives at his office seething with resentment of some real or fancied wrong, and filled with fierce hatred of his fellow men. "I'll make 'em sit up," he mutters, going over to his drawing board. He then fills in certain details of the drawing of a component. When he has done, he has produced something bang up to the specifications of the B.S.I., the R.I.C. and other strict bodies. Electrically it is first rate. But with devilish ingenuity he has introduced one feature which will ensure that many a man will tear his hair when he comes to tackle the job of making connections to it or of fixing it in position. You've met that sort of component? I thought so! Well, these switched sockets were fine examples of what the disgruntled designer *can* do. No difficulty about fixing the leads: that was soon done. Nothing remained but to mount the chosen socket on its block. Simple enough: just a couple of 1½-in screws through the vitreous body. I'd plenty of No. 8's of the right length; but the largest screws that the holes would take were a bare ⅛-in diameter. I had nothing of that size anywhere near long enough. Would you have had? Would any ordinary person? One thing that any socket needs is to be firmly and securely fixed in place with screws that get a good grip of the wood: perhaps the designer wanted two strings to his bow. Some of his victims might have had the necessary long, thin screws; but there'd be plenty of fun later when someone wrenched the socket from its moorings!

Frame Aerials

THE ARTICLE on frame aerials by G. Bramslev in the November issue and the consequent correspondence have been of considerable interest to me. I live, you see, at a place where interference of various kinds is so severe that, with capacitative aerials, long-wave reception isn't worth while. Now, you may have discovered that the Paris-Inter programmes (mainly musical) on the long waves put down a strong signal with good quality—or, rather, they would do so if it weren't for interference. Some time ago I tried using a frame and found at once that a signal/noise level of the right kind could be obtained. I find a frame very useful, too, for the reception after dark of some m.w. stations which, with an outdoor aerial, fade badly through the interaction of ground- and sky-waves. As R. A. W. Hill pointed out last month, a frame which can be tilted as well as turned in azimuth is a great help.

More Trouble at "Okey"

Writing from a village near Okehampton, a reader tells me that it is now almost impossible in his neighbourhood to obtain reasonably good reception of the West Regional programme. I referred some months ago to the trouble that had followed the inauguration of the booster transmitter at Fremington, which relays Start Point. In some parts of Devon the two sets of waves interact so severely (now that the output power of Fremington has been increased) that violent, rapid fading ruins reception. Isn't this an instance when a frame might be of use? I suggest to my correspondent that he should give it a trial and see whether he can't make use of its directional properties to reject one or other of the transmissions.

Coronation Television

IT SEEMS A PITY that the Powers that Be cannot see their way to sanctioning more temporary extensions of the television service. The transmitters at Pontop Pike and Belfast will bring so much pleasure and such lasting memories to so many people in the areas they are to serve. One cannot help regretting that dwellers in the other areas eventually to be served by the other three low-power transmitters won't be as fortunate; still, if the national resources really won't stand the strain, I suppose that those affected must just grin and bear it. We have all had by now a pretty good training in putting up with the far-from-sweet fruits of victory, a fact which any who accuse us of warmongering might do well to realize! All the same, it would not surprise me enormously if the authorities came to modify to some extent their stern attitude to-

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wards Coronation expansions of the television service. I understand that steps are being taken to try and convince the Government that the thing can be done quite painlessly and without any drain on our essential resources.

On the Continent

If, as seems likely, Radiodiffusion et Télévision Françaises decides to take the B.B.C's television transmission of the Coronation, viewers living in many European countries may be able to watch the processions to and from Westminster Abbey as well as the ceremony itself. Last summer's Franco-British television exchange showed convincingly that conversion from one standard to another was a practical proposition. In that instance it called for a conversion from the 819-line standard to a 405-line picture for this country and a 441-line picture for some French viewers. The process will have to be reversed for the Coronation transmissions. It remains to be seen whether the French engineers are able to resolve this difficulty. If so, there is no good reason why countries with 625-line systems should not be able to come to an arrangement with the French authorities for making the necessary conversion to their own standard.

Getting Them Going

The Coronation might actually be the means of getting television really under way in many European countries. The present position in Belgium, Holland, Denmark, Sweden and Italy is not unlike what it was in this country in the years just before the war. There are television services (for which, by the way, our manufacturers have supplied and continue to supply much of the equipment) covering some of the more densely populated areas. Public interest in television is enormous—but shows itself mainly in flocking to exhibitions and demonstrations. As with us before September, 1939, when the outbreak of war closed television down, people will do anything to prove their desire for television *except* buy sets! A statement on chemical lines of the existing vicious circle on the Continent might be

Poor sales of sets $\rightarrow$ Limited hours of transmission and poor programmes $\rightarrow$ Poor sales of sets

Once the ball starts rolling it rapidly gathers momentum, as we and the Americans have seen. But it takes something to get the ball started.

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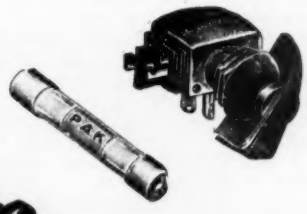

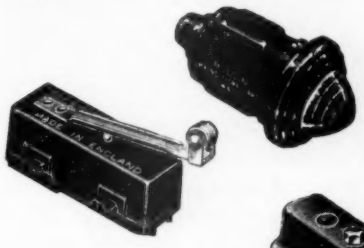

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Adding "Ionic" to Mr. Therm

IN my ignorance I have always supposed the ugly structure which is popularly called a gasometer, but is more correctly termed a gas holder, to be the perfect screening can, only equalled by a submerged submarine. Indeed, I recollect the Editor telling me, in the days of 2LO, of the reception difficulties experienced by a *W.W.* reader who lived among the gas holders hard by King's Cross station and had slung his aerial between two of them. It was not surprising that he failed to get 2LO although only about a couple of miles from the transmitter in Oxford Street.

However, modern techniques, and in particular v.h.f., have changed all that and it is now as easy to pick up a transmission when you are actually inside a gas holder as it would be on the top of the Nelson Column. It is, in fact, so easy to transmit and receive when inside a gas holder that, according to an article by a gas engineer in the January issue of the *Short Wave Listener*, when men were inside cleaning one out last summer they were provided with v.h.f. apparatus to enable them to keep in touch with their fellow workers outside.

Wireless Awheel

I HAVE little doubt that a shrill ringing of bells and a howl of execration will go up from the wobbly ranks of those who ride bicycles when I say that their habit of riding two abreast so that they can indulge in ceaseless chatter makes them the most dangerous of all users of the road. They not infrequently keep to the crown of the road while a crowd of smoke-choked motorists, who are fuming in more senses than one, trail behind them.

I was confronted with this problem in the case of my own family and have proved that there is not the slightest reason for this riding abreast in order to carry on a conversation. That was, of course, in the days before we were overwhelmed by the present deluge of car dealers all beseeching us with tears in their eyes to take delivery of the automobiles we ordered years ago.

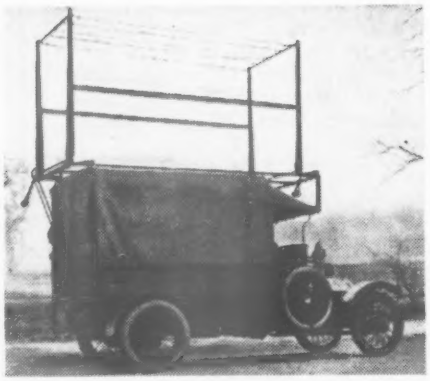
Needless to say, I found radio to be the solution of my problem and I soon had the whole family pedalling along in line astern and exchanging the usual conversational inanities. This enabled us to use the highway without causing offence to those patriotic "essential users" of new cars who honked their way imperiously along the Brighton Road every week-end, bent earnestly on the nation's business, during the "seven lean years" when new cars were quite rightly denied to us selfish pleasure-seekers. Since the required radio range was only a few feet, each of my "receivermitters" was almost as small as a couple of hearing aids, and was, in fact, a miniature "Walkie-talkie" and might, I suppose, have been named a "Bikie-Mikie" or something equally fatuous.

Calling All Cars

UNDOUBTEDLY one of the most successful applications of wireless is its use by the police to link up patrol cars with H.Q., which in the case of the Metropolitan Police is, of course, Scotland Yard. Had I been asked I should have said that police wireless started with wireless telegraphy and later graduated to the present system of telephony, but I should have been quite wrong.

There is no evidence so reliable or so readily accepted in court as that written down in a policeman's notebook and according to what I recently read in one of them the police started by using telephony at the beginning of the 'twenties. However, in view of the comparatively crude state of technique in those days it is not surprising to learn that they soon abandoned it in favour of telegraphy, although they have long since returned to telephony.

The particular "policeman's notebook" I have been reading is actually a book of reminiscences, "Hambrook of the Yard," by ex-Detective-Superintendent Hambrook which I picked up from a second-hand bookstall while the superintendent's successors were not looking. With acknowledgments to whomsoever they are due,* I have taken the opportunity of filching a photograph from the superintendent's book of one of the two first police cars with its retractable "bedstead" aerial.



The Flying Squad, 1920.

* Published in 1937 by Robert Hale & Co.

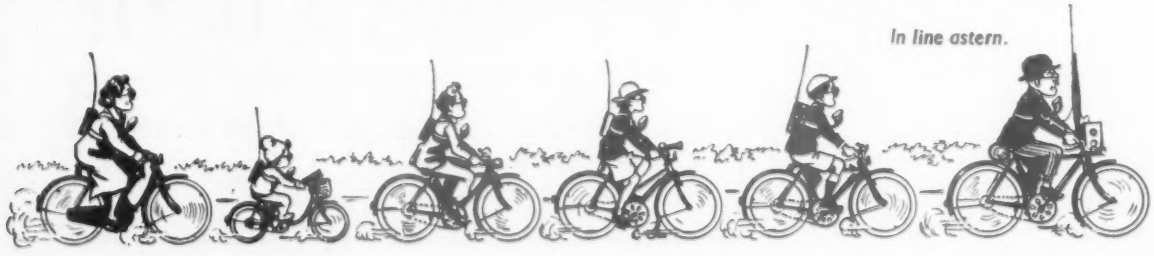
Ouida Up-to-date

I WONDER how many of you have read any of the novels, so beloved of a bygone generation, of the good lady who wrote under the name of "Ouida" and whose statue stands in the ancient city of Bury St. Edmunds. She always wrote a first-rate story but was a little apt to let herself get so carried away by the good qualities of her heroes that she credited them with the ability to perform superhuman feats. Her most famous effort occurred when describing the boat race. Her hero was in the Oxford boat, and to continue in her own words "All rowed fast, but none so fast as he."

I am reminded of this by a recent letter to the editor of one of our more sober Sabbath journals in which the writer credits the high notes of the musical spectrum with similar qualities to those of Ouida's boat-race hero; in other words, they don't keep in step with the lower notes but actually travel more rapidly. If this be so it explains a lot of things that have hitherto puzzled me.

It certainly explains why the strident screechings of sopranos have such a devastating effect on me. It is because their top notes reach my ears first, unaccompanied by any more basic sounds which would tend to tone them down.

In line astern.



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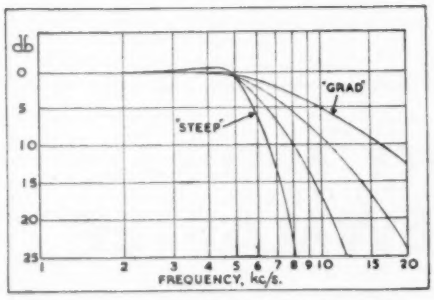
No Inductors ("Chokes") are used, and their disadvantages are completely eliminated. The turnover frequencies are 5kc/s, 7kc/s and 9kc/s and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.



Frequency amplitude curves for the "TREBLE-3" position (5kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7kc/s and 9kc/s ("–2" and "–1" positions).

The ***Vari-Slope***

The filters consist essentially of twin-T resistor-capacity networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include:

(a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."

(b) Extremely low harmonic and inter-modulation distortion due to negative voltage feedback action.

(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control, altering the terminating impedance and the insertion loss.)

(d) No chokes to cause magnetic hum pick-up.

(e) Smaller size, lighter weight, greater uniformity in production

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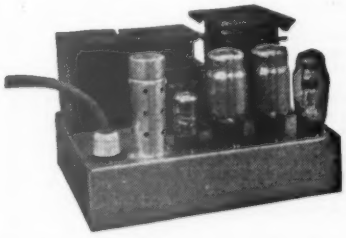

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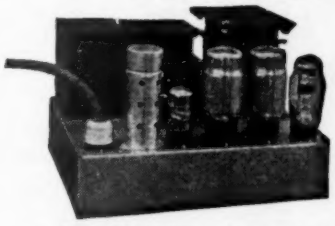

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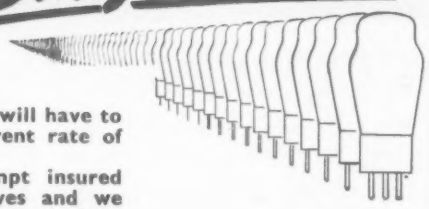

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AP141
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AS4120
AS4125
AZ1
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A20B
A50A

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BR202
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BVA42
BVA43
BVA44
BVA45
BVA47
BVA48
BVA56
B3

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CBL31
CL4
CL33
CCH35
CP220
CR34
CY1
C1
C2
C1C
C5B
C9
C10
C20C
C23B
C30B
C36A
C36C
C50B
C50N

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DC25GVM
DDA13
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DDTR13a
DDT16
DD13
DD14
DD40
DD41

DD101
DD207
DD630
DD813
DD2530
DEH610
DET19
DE3
DF51
DF91
DF92
DF496
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DK91
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DV50
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DW30
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DO24
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D42
D43
D63
D77
D92
D152
D400
D3597A

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EAF42
EAF50
EBC3
EBC33
EBC41
EBF11
EBF80
EBL21
EB4
EB34
EB41
ECC31
ECC32
ECC34
ECH21
ECC91
ECH42
ECL80
EC5
EC91
EE50
EF5
EF6
EF8
EF9
EF12
EF13
EF22
EF39
EF41
EF42
EF54
EF80
EF91
EF92
EH2
EK2
EK32
EK91
EL2
EL3
EL35
EL37
EL41
EL42
EL82
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EM35
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FC13
FT104
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HL41DD
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H30
H42
H63
H141D

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KTW61M
KTW63
KTW73
KTW81M
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KTZ41
KTZ63
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KT33C
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KT263
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K30G
K30K
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K50N
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K70D
K80A
K183
K404
K535

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LB210
LD2
LG210
LL2
LL4
LP2
LP220
L1
L2DD
L13
L31DD
L38
L77
L410

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ME17
ME41
ME91
ME920
MHD4
MHL13
MH4
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MH206
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MH4105
MH4106
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MSP4
MSP41
MU4105
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N37
N43
N144
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PEN45
PEN45DD
PEN383
PEN428
PEN453DD
PJ10
PL33
PL38
PL38M
PL82

PL83
PM2A
PM2B
PM2HL
PM3
PM12
PM12M
PM14
PM20
PM22D
PM24M
PM25
PM202
PPL4
PP3/250
PP3/425
PP5/400
PP6B
PP6C
PP6E
PP24
PP35
PP225
PP411C
PP4118
PT/DD35DA
PT10
PT24A
PT24/DAL
PT230
PV25
PX230
PX230SW
PY30
PY82
P2
P61
P140N
P215
P220A
P610

QP21
QP22B
QP25
QP42
QP230

RB41
RB120
RF120
RG250/1000
Rx210
R8

SD6
SD20
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SP2
SP2D
SP4
SP4B
SP13
SP13C
SP22
SP41
SP42
SP45P
SP61
SP210
SP220
SP1320
SP2220
SQT4
SS210
SU25
SU61
SU2150A
SW1
S3DD
S4A
S4V
S8
S23
S130
S215VM
S217
S410

TBC14
TBL14
TBL44
TB9920
TCH24

TDD2A
TDD13C
TE564
TF44
TH4
TH4B
TH13C
TH21C
TH30
TH30C
TH233
TM1

TM14
TP22
TP23
TP25
TP26
TP220
TP230
TP1340
TP2620
T5P4
TT4
TT4A
RX21
T4
T20
T31
T32

UAF41
UAF42
UBC41
UBF80
UB41
UCH21
UCH42
UD41
UFW29C
UF41
UF42
UL41
UL44
UL46
UM34
UR1C
UR3C
UR13
UU3
UU7
UU9
UU30/250
UU41
UX6
UY21
UY41
U4
U16
U17
U18/20
U21
U22
U24
U25
U31
U33
U35
U37
U50
U70
U71
U74
U76
U78
U81
U82
U84
U101
U142
U145
U281
U404
U914
U920

VMP4G
VM4K
VPT4
VP2B
VP2D
VP4

VP4A
VP4C
VP13
VP13A
VP13B
VP13C
VP13K
VP13X
VP14
VP20
VP23
VP28
VP41
VP41E
VP60
VP133
VP210DD
VP1320
VW48
V9
V30
V914
V1907
V5116

WD142
W21
W76
W77
W81M
W101M
W142
W143
W154
W147
W148

X7
X22
X24
X61M
X63
X64
X65
X71
X73
X73M
X76
X76M
X78
X79
X81
X101
X138
X142
X143
X148
X150
X410

Y13
Y63
Y220

ZD2
ZD17
ZD
Z14
Z21
Z22
Z26
Z63
Z77
Z152

0X5G
0Z4
01A
01307M

1A4
1A4E
1A5G
1A5GT
1A6
1A6E
1BC1
1BE4
1B5/25s
1B7G
1B42
1B122
1C1
1C5
1C7

1D5
1D5G
1D6
1D7G
1D8
1FW4A
1F2
1F3
1F5G
1F6
1F7
1G4
1G6
1H4G
1H5G
1J6
1LA4
1LA4E
1LA6
1P10
1P11
1RF120
1R5
1S4
1T4
1T5GT
1V

2
2A6
2A7
2A8
2D2
2D4A
2D13
2D13A
2D13C
2D17
2YR215
2Z3

3D6/1299
3Q5
3V4
3Y4

4
4D1
4THA
4TSA
4TPB
4XP

5
5U4G
5V4G
5X4G
5Y3G
5Y4
5Y3S
5Z3
5Z4

6AB7
6AC7
6AE5
6AM6
6A3
6A6
6AT6
6A8EG
6A8G
6BA6
6BG6G
6B4G
6B7E
6B7G
6B7M
6B7
6B8E
6B8G
6CD6
6C4
6C5
6C6
6C8
6C9
6C10
6D1
6D3
6D4
6D6
6E5

6F1
6F6
6F7
6F8G
6F12
6F13
6F14
6F15
6F16
6G5
6G6
6H6
6H7
6J5
6J7
6J8
6K5
6K6
6K7
6LD20
6LF8
6L1
6L5
6L6
6L6GA
6L7
6L18
6L19
6M1
6N6G
6N7
6P5
6Q7G
6R7G
6SA7
6SF7
6SG7
6SQ7
6SH7
6SJ7
6SK7
6SL7
6SN7
6SQ7
6SS7
6S7G
6T7
6U5
6U7
6V6
6W5G
6Y4
6ZY5
6Z5

7A3
7A3
7A7E
7B5
7B6
7C5
7C7E
7D3
7D5
7D8
7H7
7K7
7Q7
7R7
7S7

8
8A1
8D2
8D3

9D2

10
10C1
10D1
10D2
10F1
10F3
10F9
10LD11
10P13
10P14

11D3
11D5
12AL5
12AT7

12AU6
12AU7
12AX7
12A5
12A6
12A8
12J5
12J7
12K8
12Q7
12SA7
12SF5
12SG7
12SH7
12SJ7
12SK7
12SQ7
12SR7

13D1
13SPA
13VPA

15
15A2
15D1
15D2
15E

17

18

19
19BG6

20C
20D1
20D2
20F2
20IPT
20L1
20P1
21A
22N41
24
24A
24E
25B5
25A6
25L6
25Z5
26
27
28D7
30
31
32E
33
34
35
35A5
35C5
35L6
35Z3
35Z4
36
36E
37
38
38E
39/44
39/44E
41MDG
41MH
41MHL
41MP
41MPG
41MRC
41MSG
41MTA
41MTL
41MTS
41STH
41MXP
42
42A
42E
42MPT
42PTB
43
44E
45IU
46
48
49A

50C5
50L6
58
61BT
62BT
62DDt
62TH
62VP
66KU
67BT
71A
75A
75
76
77
78
83
84
101
104V
105G5
110
112A
120
124
150
150A
150B
185BT
2s2DDT
202MPG
202STH
202VPB
202VP
210DDT
210HF
210LF
210PG
210RG
210VPA
210VPT
215SG
2201PT
220P
220PA
220PT
220VPB
222JH
224
230PEN
240QP
290L4
301
302
307A
329
340
369BX
408BU
410HF
415PO
415XP
423PT
424
425P
425XP
431U
523
607G
625
635
646G
696
802
807
1215GT
1506
1642
1701
1904
1912
1915
1920
1927
1928
2060
2102
3355
9004
13201A
6153T

Advertisement by Electronic Precision Equipment Ltd., see overleaf.

22/6 FLUORESCENT LIGHTING

Complete kit comprises Hi-craft 40 watt control unit, starter lamp, lamp holders, clips and wiring diagram. Price, less tube, 22/6, plus 1/6 post. Tubes 12/6 each, carr. free, minimum quantity 6.

SOMWEAVE

This really lovely loudspeaker fabric we offer at approximately a third of today's cost. It is 42in. wide and our price is 12/- per yard or panels 12in. × 12in., 1/9 each. This is also very suitable for covering plain wooden cases, for portable radio amplifiers, etc.

CARBON RESISTORS

These will now be supplied in individual packets, with the value and wattage clearly indicated.

Prices: ¼-watt, **4d.** each; ½-watt, **5d.** each; 1 watt, **6d.** each.

Resistor Kits.

Each resistor individually packaged as above. Popular assortment as shown below.

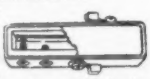
Ω	W	No	Ω	W	No
22	1	1	39K	½	4
68	½	3	47K	½	4
150	1	1	68K	½	2
330	½	1	68K	1	1
470	½	4	150K	½	3
820	½	1	330K	½	1
2.2K	½	1	560K	½	4
6.8K	½	1	680K	1	2
10K	½	4	1Meg	½	4
22K	½	4	1Meg	1	2
25K	1	1	22Meg	½	1

Kit 1. 50 Resistors as above table **12/6**
Kit 2. Double quantity .. **22/6**
Kit 3. Four times quantity **37/6**

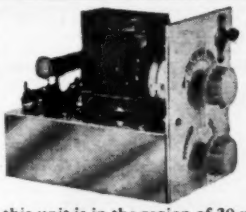
4in. NAVIGATION COMPASS

Sturdy and reliable. Floating dial, shock mounted in metal case. All cardinal points and degrees marked. Each compass in wooden box. Exceptionally low price. 20/-, plus 2/- postage.

ADJUSTABLE THERMOSTAT



250 v. heavy silver contacts can be adjusted to operate between 70°–300° F. These are suitable for aquarium heaters, electric blankets, etc.
1 Amp. Model, 3/6.
2 Amp. Model, 5/6. 5 Amp. Model, 14/6. Post, etc., 6d. extra. Don't be cold this winter, make an Electric Blanket, blueprint 1/6 post free.

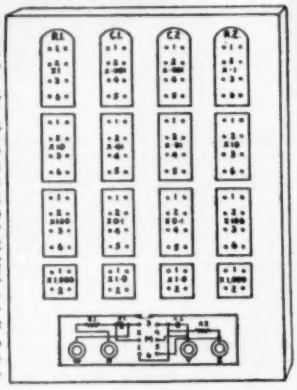


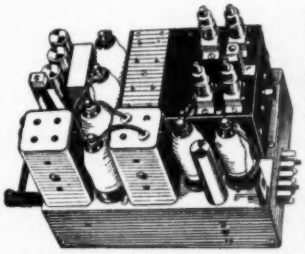
POWER UNIT FOR MODELS

This Power Unit is designed for the operation of one or two electric trains, or similar applications requiring an A.C. voltage of up to 12.2 at 1 amp.
The unit is fitted with a continuously variable speed control, regulating the output from 6.5 to 12.2 volts under load.
Other controls include double pole reverse switch and mains on/off switch. The power consumption of this unit is in the region of 30 watts A.C. mains from standard supply. In practice this power-pack is capable of controlling models from almost standstill to full speed. It is intended for continuous working. A full wave bridge type network is used for rectification.
Complete kit of parts, including case, 35/-, on unit made up ready to work, 39/6.

EQUIP YOUR LABORATORY

You many times have felt the need of a device which would enable you to put resistance or capacity or a combination of these two quickly into a circuit. We have a small quantity of resistance capacity boxes which, by the simple manipulation of plugs, will enable you to do this. With these boxes you can put in 1 ohm, 2 ohms, 3 ohms, 4 ohms, and so on, in steps of 1 ohm, right up to 6,000 ohms. In a similar way capacity can be put into circuit by small amounts, thus making it simple for you to find optimum working conditions. These boxes made for Government Laboratories are available while they last at 19/6 each, plus 1/6 post and packing. Don't delay—order by return.





RECEIVER TYPE 25/73

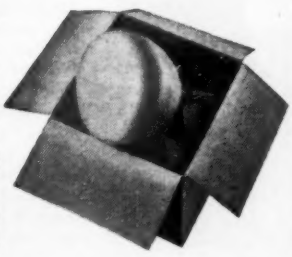
Receiver portion of the TR.1196, undoubtedly one of the most useful little receivers that has ever been offered from Government Surplus Stores, because once the existing tuning unit is removed a standard coil pack can be fitted which makes a very efficient superhet at a very small figure. Alternatively for breaking up there is a pair of standard 465 kc/s dust-cored, IF transformers which would cost 12/6–15/-, and dozens of other items, tuning condensers, coils, preset condensers, pot. meters, etc., etc. The price is only 9/6, plus 1/6 post and packing, less valves.

UNBREAKABLE GLASS

We can offer at approximately a quarter of its cost. This glass, as many readers will know, can be dropped and will not break. In fact it is most difficult to break, and is so useful for dozens of applications in addition to its original purpose of protecting viewers against flying glass in the event of an exploding Cathode Ray Tube.
We offer a parcel of five panels each 10¾ × 9¼in. for 7/6, post free.

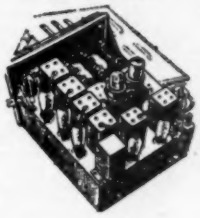
VIEWMASTER
All parts available, send for up-to-date price list.

STILL AVAILABLE
15in. MAGNETIC TELEVISION TUBE



By famous maker, as used in many popular Television receivers (list on request). Specification Blue/White screen 9 Kv. ion trap triode, heater 6.3 v. at .55 amp., 50° deflection. New, with written guarantee offered at approximately half price, £12/10/- each, plus 10/- carriage and insurance. H.P. terms £4/4/- deposit and 12 monthly payments of 18/3. Limited quantity, so order immediately.

GOVERNMENT SURPLUS EQUIPMENT



10-VALVE 1¼-METRE SUPERHET

Ideal for conversion into a Televisor. These contain 6 valves type SP61, and one each RL7, RL16, and EA50. Six IF transformers of 12 Mc/s. band width, and hundreds of other useful components. Price 59/6, plus carriage and packing 7/6. These receivers are unused and in original wrappings.

RDF1

Ex-Army unit contains 13 valves as follows: 5 of SP61, 2 of P61, 3 of EA50, and CV63, EB34, EC52.
In an article entitled the "£9 Televisor," published in "Practical Television," details are given showing how to make a Televisor using this unit. A reprint of this article is given free to all purchasers. Price 49/6, carriage and packing 5/-.

RECEIVER R1124

This receiver contains a host of useful stuff, the most important of which is a coil pack which needs only the adjustment of its trimmers to receive A.P. sound. The valves contained are three type 9D2 and one each of 8D2, 4D1 and 15D2. We understand that these receivers have never been used. Price only 18/6, each plus 2/6 postage.

RF UNIT TYPE 24

Contains 3 valves, SP61 and miscellaneous HF components ideal for conversion for all TV frequencies. Supplied complete with conversion data. Price 25/-.

POWER PACK TYPE 392

This is an extremely useful unit which works off A.C. without modification, giving an output of 700 v. D.C. adequately smoothed. Components include: Mains Transformer for 200-250 v. 50 cycles, with secondaries of 700-0-700 v. at 70 mA., 4 v. at 2.5 amps., 12.5 v. at 1 amp. (Note these are Admiralty ratings, the transformers will stand at least twice these figures.) Also 2 rectifier valves, type CV54, 10-watt resistors, three 4 mfd. 700 v. condensers, L.F. choke, 10 henry 100 mA. The power pack is unused and is contained in a louvred case size 12in. × 5¾in. × 8¼in., but these may have superficial external damage, broken fuse holders, etc. Price 57/6, post and packing 5/-.

FULL PICTURE VCR97

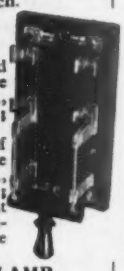
We have had a new delivery of this now-famous electrostatic 6in. T.V. tube, these are not the cut-off type, and we guarantee a full picture, 42/6, carriage and insurance 5/-.

Advertisement of Electronic Precision Equipment Ltd., see overleaf

AMERICAN ELECTRICAL EQUIPMENT

Intended for use by the U.S. Army for field lighting, but ideal for garden lighting, temporary installations, etc., from mobile generator or from the mains.

GLASS INSULATOR
Complete with iron bracket for mounting on pole, wall, tree, etc. Also suitable as aerial insulator. Price 3/6 each.



FUSED KNIFE SWITCH
For isolating and switching, complete with fuses. 5 amp., 3/6; 30 amp., 4/6; 60 amp., 6/-.
Note spare fuses of the correct size are obtainable: 5 amp., 6d.; 30 amp., 9d.; 100 amp., 1/-. But in any case a burnt-out fuse can be repaired.

LAMP-HOLDERS
Weatherproof, these take a standard Edison screw, 1 amp., which are the best to use outside, as they are not so likely to be pilfered. 1/6 each.

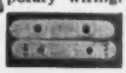
Another Edison screw holder but switched. 2/6 each.

A two-way Edison screw adaptor for the spot where you find you require additional light. 1/9.

10 AMP. SWITCH
Rotary pattern with chrome cover and on/off indicator. 2/3.

REFLECTOR
Green and white with gallery. 2/6.

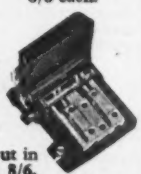
PORCELAIN CLEATS
Two groove, 4d. pr. For all temporary wiring.



INSULATORS
Split knob, 4d. each, with fixing pin.

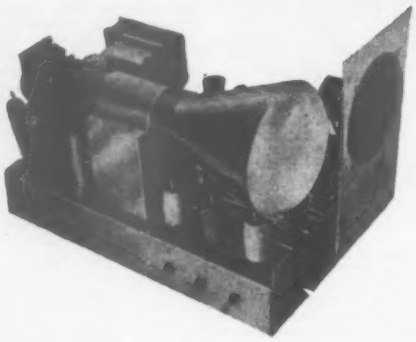
CLIX 15 AMP. FOOT PLUG
Made to B.S.S. specification, shuttered in moulded bakelite case, 8/6 each.

IRON CLAD SWITCH FUSES
Best makers M.E.M., etc.
15 amp., 10/6, plus 1/6 post.
30 amp., 16/6, plus 2/6 post.
15 amp., used but in good condition, 8/6.
10 amp. porcelain (Memdix), 6/-.



THE "P.T." 'ARGUS' TELEVISION RECEIVER

A 21 Valve 6in. C.R. Tube Unit-built Televisor for the Amateur



Although this televisor costs only about £20, it does not involve the conversion of ex-Government units, and has been designed for construction by the novice. The circuits have been kept straightforward and devoid of "frills," though nothing has been sacrificed which would assist in its efficient and stable operation.

The cathode-ray tube used is a VCR97. This 6in. tube was chosen as it is readily available at a low cost, and is capable of providing pictures of very good quality. The trace is green, but one soon becomes accustomed to the colour, and it is very restful to the eyes.

The chassis is divided into five separate units which makes for ease of construction; the units are vision receiver, sound receiver, time base, E.H.T. Supply and C.R.T. network and power unit. Each unit is complete on its own chassis, and when finished all units are bolted together to form the complete televisor.

All components, resistors, condensers, valves, etc., come to £20/10/-. H.P. terms £6/17/- deposit, balance by 12 monthly payments of £1/9/9.

The constructional details show how to make up the metal chassis, tube supports, etc., but for those not wishing to do this metal work themselves we can offer ready drilled chassis and all mechanical details fully prepared for £3. Also the £20/10/- does not include such small items as nuts and bolts, connecting wire, solder and other sundries which most readers will already have, but these again can be supplied at competitive prices. List on request.

SIX INCH TUBE LOOKS LIKE NINE INCH

The illustration alongside shows the Argus fitted into our standard Console Cabinet using our "internal magnifier system," full details of which can be supplied on request. It is interesting to note also that this magnifier system is equally applicable to any Televisor using a 6in. C.R.T., whether table model or Console. The outfit comprises magnifier mask and veneered front with four secret head screws. Price is 39/6, plus 2/6 post and packing.

The cabinet is our standard model, suitable for Viewmaster, Teleking and almost any home constructed Televisor, and price is £7/17/6, plus 10/- carriage and insurance.

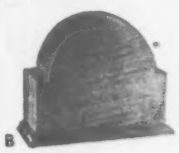
Note. Any or all of the above can be supplied on H.P. You send a deposit equal to one-third of total cash prices, together with carriage charges, and the balance is payable over 12 months.

A reprint of the data which originally appeared in "*Practical Television*," together with some additional diagrams and notes produced by our Television engineers are available as a constructor's Envelope. Price 5/-, post free.

UNCUT CLOCK CASES

A

C


B

D

Clock cases, uncut but veneered and polished, very suitable for mounting electric or clockwork movements, also meters, barometer, etc. Price 8/6 each, plus 1/- post. Please give an alternative shape in case stock runs out.

TRANSFORMER BARGAINS

250 mA. 350-0-350 v., 6.3 v. at 6 amps., 5 v. at 3 amps., 4 v. at 5 amps. Price 37/6.
200 mA. 425-0-425 v., 6.3 v. at 4 amps., 6.3 v. at 4 amps., 5 v. at 3 amps. Price 50/-.
150 mA. 300-0-300 v., 7.5-0-7.5 v. at 3 amps., 4 v. at 3 amps. Price 17/6.
120 mA. 350-0-350 v., 4 v. at 4 amps. C.T., 4 v. at 2 amps. C.T. Price 42/6.
100 mA. 350-0-350 v., 6.3 v. at 4 amps., 5 v. at 3 amps., fully shrouded upright mounting. Price 27/6.
100 mA. 250-0-250 v., 6.3 v. at 6 amps., 5 v. at 3 amps., fully shrouded, upright mounting. Price 27/6.
80 mA. 350-0-350 v., 0-4-6.3 v. at 5 amps., 0-4-5 v. at 2 amps. Price 19/6.
80 mA. 300-0-300 v. 6.3 v at 4 amps. C.T., 5 v. at 2 amps. upright mounting. Price 19/6.

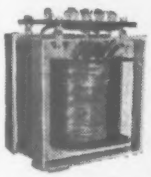
70 mA. 235-0-235 v. 4 v. at 4 amps., 4 v. at 1 amp., upright mounting. Price 22/6.
40 mA. 325-0-325 v., 6.3 v. at 3 amps., upright mounting. 15/6.
Please add 1/6 post on each transformer.

FILAMENT TRANSFORMERS

For standard 230 v. mains.

12 v. 1 amp.	8/6
6.3 v. 1.5 amp.	6/6
6.3 v. 2 amp.	8/6
4 v. 2 amp.	7/6
6.3 v. 3 amp.	15/9
6.3 v. 6 amp.	20/-

Plus 1/- postage.



AUTO TRANSFORMERS
For working American equipment off our mains, etc., etc. Input tapped 200-240 v. Output 115 v.

Totally enclosed and screened.

	Price	Carr.
40 watt	16/3	1/6
60 watt	19/6	1/6
100 watt	£1/4/6	1/6
150 watt	£1/11/-	2/-
250 watt	£2/9/-	2/6
500 watt	£4/17/6	2/6

Unscreened.

1 KVA (1,000 w.)	£6/10/-	5/-
1.5 KVA (1,500 w.)	£7/17/6	5/-
2 KVA (2,000 w.)	£10/17/6	7/6
3 KVA (3,000 w.)	£12/7/6	10/-
5 KVA (5,000 w.)	£19/5/-	12/6

HIGH FIDELITY OUTPUT TRANSFORMERS

20 w. Push-pull, fully shrouded for 3 or 15 ohms operation in the following primary impedances: 10,000 ohms, 8,000 ohms, 6,000 ohms, 4,000 ohms. 30/-, post 1/6.

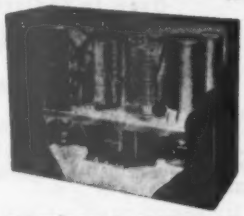
L.F. CHOKES

50 H	30 mA.	6/6
50 H	20 mA.	6/6
30 H	20 mA.	6/6
20 H	10 mA.	5/6
15 H	80 mA. fully shroud.	15/-
10 H	150 mA. " "	18/-
10 H	100 mA. " "	15/-
10 H	75 mA.	4/9
10 H	60 mA.	4/9
5 H	250 mA. fully shroud.	20/6

Please add 1/- post. & pkg.

POLE CLIMBERS GAFF
Complete safety strap, belt and foot spikes, £2/10/- per set.

Advertisement of Electronic Precision Equipment Ltd.



BATTERY ELIMINATOR

This is a vibrator type power pack which gives 150 volt at 50 mA. of L.T. suitable for all dry sets from 4 or 6 v. or similar battery. Ex-W.D., of course. Price 29/6, plus 2/6 post and packing.

RADIO STETHOSCOPE

A novel device aptly called a Radio Stethoscope is described in a recent edition of the "Radio Constructor." This is compact and can be slipped into the pocket rather like a fountain pen. With it in most districts a receiver can be checked from the grid of the first valve right through to the output without a signal generator, the stethoscope will operate in both L.F. and R.F. circuits without alteration. It is a complete fault finder.

The only parts needed to make the simple circuit tracer are a pair of crocodile clips, a germanium crystal, and a paper tubular condenser, and we will supply whole outfit for 6/6, post free, and with each outfit we will give re-print of the article as it appeared in the "Radio Constructor."

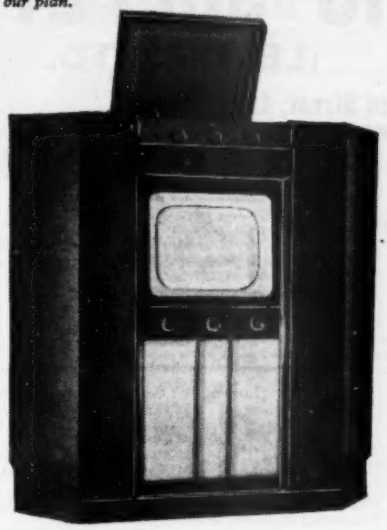
NOTE.—If you wish to make it up as a pocket unit then you will need a few other odds and ends, solder tags, etc., from your spares box.

SPRAY GUN

Hand operated, ideal to put a good finish on a completed chassis, and for respraying valves, etc. (completes the perfect job). Price 15/6 complete with instructions, plus 9d. postage.

CORONATION CONSOLE

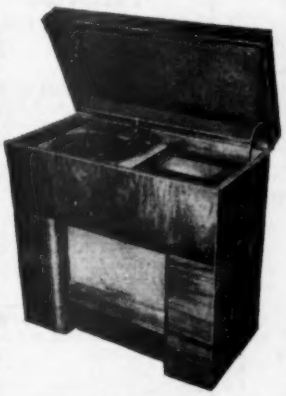
A combined Radio, Radiogram and 15in. Televisor in a magnificent cabinet valued at a shop price of £300–£400 can be yours for about £75 if you adopt our plan.



OUR PAY AS YOU BUILD PLAN

As soon as we are ready to send the parts we will ask you to forward **£12/10/-**, upon receipt of which we will send you parts for the Television section. From then on you can send us **30/-** every week and we will send you other sections in the following order: Radio, Audio Chassis, Cabinet and finally Record Changer unit.

First send 7/6 for all the details. Ask for "Coronation Console Constructors Envelope." Upon studying it we feel sure you will want to make the Console, but the data will be on 7 days' approval, and if you wish you can return it within this period, and providing it is received in clean condition 7s. will be refunded to you.



29 gns. RADIOGRAM Console Type Cabinet. With full grained walnut finish, will take standard type auto change gram unit. Price **£11/10/-**. H.P. Terms, **£3/17/-** deposit, and 12 monthly payments of **16/9**, plus 15/- carriage.

Radio Chassis to suit. £8/19/6. H.P. Terms, **£3** deposit and 10 monthly payments of **13/-**, plus 7/6 carr.

Auto Change Units. For long playing and standard records with suitable pick-up head, **£11/11/-**.

SPECIAL OFFER. Cabinet, Radio Chassis and Auto Changer, **29 gns.** H.P. Terms, **£10/14/-** deposit and 12 monthly payments of **£2/3/-**.

THE ELPREQ GENERAL PURPOSE AMPLIFIER

A self-contained A.C./D.C. mains operated amplifier which has 101 applications such as for dance band in small halls, factory call system, gram. amplifier, baby alarm, etc., will drive 4 extension speakers. Complete with hand microphone and built-in speaker in portable carrying case, fully guaranteed, **9 gns.**, or H.P. **£3/4/-** deposit, plus 5/- carr. and ins.

CONNECTING WIRE SNIP

P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Colours available: Black, Brown, Red Orange, Pink, Yellow, White, Transparent. 4 coils for 10/-.

METAL RECTIFIERS

The one illustrated is a special bargain, being available at considerably below cost. It is a selenium type rectifier rated at 12 v. 2½ amps., it is of course a full wave type highly suitable for battery chargers. Limited quantity. Price 17/6 each.

Also available 6 v. 1 amp. Type. Prices 5/- each. 12 v. 1 amp. Type. Price 9/- each.

SPECIAL OFFER

Metal Rectifier, 100 mA. 250 v. Ex new equipment but unused and perfect. Price 7/6 each.

SLIDER RESISTORS

Heavy Duty Type.

Size 7in. × 1¼in. 11 ohms 4.5 amp., **22/-**; Size 9in. × 1¼in. 1.2 ohms 15 amp., **15/-**; Size 13¼in. × 1¼in. 3 ohms 10 amp., **15/-**.

ELECTRONIC PRECISION EQUIPMENT LTD.

We have moved in at last so you can now address your orders to :—

ELPREQ HOUSE (Ref. 2), HIGH STREET, WEALDSTONE, MIDDX.

Personal shoppers however should continue to call at :—

42-46, WINDMILL HILL, RUISLIP, MIDDX.
Phone: RUISLIP 5780
(Half-day, Wednesday).

152-153 FLEET STREET, E.C.4.
Phone: CENTRAL 2833
(Half-day, Saturday).

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under £1, 1/6 extra under £3.

RADIO SUPPLY CO.
(LEEDS) LTD.

15 Wellington Street, Leeds 1 Tel. 22153

Open to Callers: 9 a.m. to 5.30 p.m. Saturdays until 1 p.m.
FULL PRICE LIST 5d.
TRADE LIST 5d.
Please enclose S.A.E. with all enquiries.

SPECIAL OFFERS. Midget Mains Transformers (size approx. 2½×3×2½in.). Drop-through chassis type. Screened Primary 220/240 v. 50 c/s. Output: 250-0-250 v. 60 mA., 6.3 v. 2.5 a. Only **10/9**. Small Filament Transformers, 220/240 v. input, 6.3 v. 1.5 a. output, **5/9**. Auto Transformers (with separate l.t. 6.3 v. 1.5 a.), 0-110-200-210, 230-250 v. 50 watts, **4/9** each. New Boxed Ex-Govt. Valves, VR126 (4 v. 7-pin H.F. Pentode), **1/9** each.

BATTERY SET CONVERTER KITS. All parts for converting any type of Battery receiver to All Mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed h.t. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed l.t. of 2 v. at up to 1 a. Price complete with circuit, only **47/9**.

PERSONAL SET BATTERY SUPERSEDER KIT, complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal 200-250 v. 50 c/s Mains. Price with circuit **29/6**.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformer, h.t. and l.t. rectifiers, smoothing electrolytic, and choke, adjustable charger resistor and case. For Mains input of 200-250 v. Output 120 v. 40 mA. and 2 v. ½ a. Price with circuit, **29/6**.

H.T. ELIMINATOR KIT. Consisting of Mains Transformer (200-250 v. input), smoothing choke, metal rectifier, 32-32 mfd. smoothing Elect., Tapped Dropper Resistor and circuit. Price **21/9**.

BATTERY CHARGER KITS
For 200-250 v. 50 c/cs. Mains input.
To charge 6 v. acc. at 2 amp, **25/9**.
To charge 6 or 12 v. acc. at 2 a., **29/6**.
To charge 6 or 12 v. acc. at 4½ a., **49/9**.
Above consists of transformer, full wave rectifier, fuse, fuseholder, steel case and circuit.

SELENIUM RECTIFIERS. 230 v. 50 mA., H.W. (small), **6/9**. 120 v. 40 mA., H.W. (small), **4/6**. 12-15 v. 2 a. F.W. Bridge, **10/9**. 12-15 v. 4 a., F.W. Bridge, **18/9**.

ELECTROLYTICS (Current production. Not ex-Govt.).

Tubular Types		Can Types	
8μF 450 v.	1/11	16μF 450 v.	2/9
8μF 500 v.	2/9	24μF 350 v.	2/11
16μF 350 v.	2/3	32μF 350 v.	2/11
16μF 450 v.	2/9	40μF 450 v.	4/9
16μF 500 v.	3/9	50μF 350 v.	4/9
24μF 350 v.	3/3	8-8μF 350 v.	3/9
32μF 350 v.	3/9	8-8μF 450 v.	3/11
8-16μF 500 v.	4/11	8-16μF 450 v.	4/6
25μF 25 v.	1/3	16-16μF 450 v.	4/11
25-25μF 25 v.	1/9	16-16mfd. 500 v.	5/9
50μF 12 v.	1/3	16-32μF 350 v.	4/9
25μF 50 v.	1/9	32-32μF 350 v.	4/9
50μF 50 v.	2/3	32-32μF 450 v.	5/11
		50-50μ350μF	5/11
		3,000mfd. 6 v.	6/9

CAN TYPES
32-32-8μF 350 v. (Small) 5/11
16-16μF 450 v. plus 20μF 25 v. 5/3
32-32μF 350 v. plus 25μF 25 v. 5/11
50μF 350 v. plus 250μF 12 v. 4/11

CHASSIS. (16 s.w.g. Undrilled Aluminium) Receiver type. 6×3½×1½in., **1/11**; 7½×4½×2in., **2/9**; 16 s.w.g. 10×5½×2in., **3/9**; 11×6×2½in., **4/3**; 12×8×2½in., **5/3**; 16×8×2½in., **7/6**; 20×8×2½in., **8/11**; Amplifier Type, 12×8×2½in., **7/11**; 16×8×2½in., **10/11**; 14×10×3in., **12/6**; 20×8×2½in., **13/6**.

SILVER MICA CONDENSERS. 5μμF, 10μμF, 15μμF, 20μμF, 25μμF, 30μμF, 35μμF, 50μμF, 120μμF, 150μμF, 180μμF, 200μμF, 230μμF, 300μμF, 330μμF, 400μμF, 470μμF, 500μμF, 1,000μμF (.001μF), 2,200μμF (.0022μF). All at **6d.** each. **3/9** dozen one type.

TUBULAR WIRE-ENDED CAPACITORS (New Stock). .001μF 750 v., .01μF 750 v., .02μF 1,500 v. (large), .02mfd. 500 v., .05μF 350 v., .1μF 350 v., .25μF 350 v., .5μF 400 v. All at **4d.** each, **3/3** dozen one type, **27/6** gross.

A 4-WATT AMPLIFIER FOR £3/10/0. Complete kit of parts for construction of a high gain amplifier with push-pull output. Anode dissipation 10 watts. Suitable for use with any type of pick-up. Both Gain Control and Tone Control are incorporated. Circuit diagram is supplied, and the fully assembled amplifier can be purchased at an extra cost of **25/-**. At present we have only very limited stocks of these kits, and after disposal we may be unable to repeat. If further particulars are required, stamps 1/- will bring descriptive leaflet.

BAKELITE (Brown or White) and **WOOD** (Walnut veneered) **CABINETS.** Size approx. 12×6½×5in. Very attractive appearance. For illustration see our List. Supplied complete with fully punched T.R.F. 3-valve Chassis, back, 2 or 3 wave. Glass scale with coloured station names, Dial Backplate, **25/-**, plus Carr. 2/6.
All parts available for construction of T.R.F. or Superhet Receiver in above cabinets.

VOLUME CONTROLS with long spindles, all values less switch **2/9**, with S.P. switch **3/11**. **WIRE WOUND POTS.:** 5K, 10K, 20K, 25K, 50K (medium length spindles), **2/9**.

FOR CALLERS ONLY. Mains Trans., drop-through type with top shroud. Primary 230-250 v. Secs. 425-0-425 v., 200 mA., 300-0-300 v. 100 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a., **29/9**.

COAXIAL CABLE, 75 ohms, ¼in., **10d.** yard.

DIAL BULBS, M.E.S., 6.5 v. 0.15 a., 8 v. 0.15 a., **6/9** dozen.

VALVE SCREENING CANS. International Octal 3 piece, B7G (Button Base) 2 piece **10/6** doz., **1/3** each.

EX-GOVT. ITEMS. Pye coaxial plugs and sockets **7/6** doz. prs. Belling-Lee moulded type 5-pin plugs and sockets, **1/11** pr. .02 mfd. 5,000 v. Tubulars, **1/9**.

EX-GOVT. SMOOTHING CHOKES
Potted Types
330 mA. 5 H. 50 ohms **12/9**
220 mA. 5 H. 50 ohms **10/9**
150 mA. 10 H. 200 ohms **10/6**
50 mA. 50 H. 1,250 ohms **8/11**

EX-GOVT. BLOCK PAPER MANSBRIDGE TYPE CONDENSERS
4μF 500 v. **4/11**
4 mfd. 1000 v. **3/3**
8μF 500 v. **4/9**

P.M. SPEAKERS. All 2-3 ohms, 5in. Plessey, **13/9**, 5in. Goodmans, **14/9**, 6½in. Elac, **14/11**, 6½in. Plessey with Pentode Trans., **14/11**, 6½in. Goodmans, **16/9**, 8in. Plessey, **15/9**, 10in. Goodmans, **31/-**, 10in. Plessey, **18/6**.

M.E. SPEAKERS. All 2-3 ohms, **4in.** E.M.I with trans. Field 700 ohms **14/9**, 6½in. Rola field 700 ohms **11/9**, 8in. R.A. field 600 ohms **12/9**, 10in. R.A. field 600 ohms **23/9**.

COLLARO TAPE DESK MOTORS, shaded pole type, clockwise or anti-clockwise, **29/9** each.

R.S.C. MAINS TRANSFORMERS
Fully Guaranteed. Interleaved and Impregnated.
Primaries 200-230-250 V. 50 c/s Screened.

TOP SHROUDED, DROP THROUGH
260-0-260 v. 70 mA., 6.3 v. 3 a., 5 v. 2 a.... **14/11**
260-0-260 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. ... **15/9**
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.... **16/6**
350-0-350 v. 90 mA., 6.3 v. 3 a., 5 v. 2 a. ... **21/9**
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.... **23/9**
300-0-300 v. 100 mA., 6.3 v.-4 v., 4 a., c.t. 0-4-5 v. 3 a. **23/9**
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a. **23/9**
350-0-350 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.... **28/9**
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.... **29/11**
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. **29/11**

FULLY SHROUDED UPRIGHT
250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2½-3-3in. **17/6**
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.... **18/9**
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a. **25/9**
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for 1355 conversion **29/9**
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a. **25/9**
350-0-350 v. 100 mA., 6.3v.-4 v. 4 a. c.t., 0-4-5 v. 3 a. **25/9**
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.... **33/9**
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. **33/9**
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a. **45/9**
350-0-350 v. 250 mA., 6.3 v. 6 a., 4 v. 8 a., 0-2-6 v. 2 a., 4 v. 3 a. for Electronic Eng. Televisor **67/6**
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a. c.t., 6.3 v. 4 a., c.t., 0-4-5 v. 3 a., suitable Williamson Amplifier, etc. **51/-**
425-0-425 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a. **65/6**
325-0-325 v. 20 mA., 6.3 v. 0.5 a., 6.3 v. 1.5 a. for Williamson Preamplifier **17/6**

FILAMENT TRANSFORMERS
All with 200-250 v. 50 c/s. primaries: 6.3 v. 2 a., **7/6**; 0-4-6.3 v. 2 a., **7/9**; 12 v. 1 a., **7/11**; 6.3 v. 3 a., **10/11**; 6.3 v. 6 a., **17/6**; 0-2-4-5-6.3 v. 4 a. **18/9**; 12 v. 3 a. or 24 v. 1.5 a., **17/6**; 0-5-6.3 v. 5 a., four times, giving up to 24 v. 5 a. up to 12-6 v. 10 a., up to 6.3 v. 20 a. by series or parallel connections, **55/-**.

CLAMPED UPRIGHT MOUNTING
300-0-300 v. 100 mA., 6.3 v. 3 a., 5 v. 3 a.... **21/9**
350-0-350 v. 100 mA., 6.3 v. 3 a., 5 v. 2 a.... **21/6**

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., **14/9**; 0-9-15 v. 3 a., **16/9**; 0-0-15 v. 6 a., **22/9**; 0-4-9-15-24 v. 3 a., **22/9**; 0-9-15-30 v. 3 a., **23/9**.

SMOOTHING CHOKES
250 mA., 8-10 H., weight 12 lb. **16/9**
100 mA., 10 H. 200 ohms **7/6**
80 mA., 10 H. 350 ohms **5/6**
60 mA., 10 H. 400 ohms **4/11**
50 mA., 50 H. 1,000 ohms **9/11**

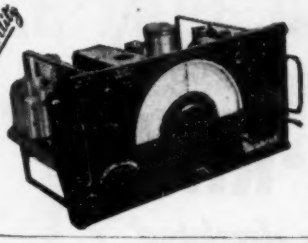
ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s., 120 v. 40 mA.... **7/11**
90 v. 10 mA., 9-0-9 v. 250 mA. **10/6**
120 v. 40 mA., 6 v. 1.5 a. **14/9**
120 v. 40 mA., 6-0-6 v. 1.5 a. **15/9**
E.H.T. TRANSFORMERS. 2,500 v. 5 mA., 2-0-2 v., 1.1 a., 2-0-2 v. 1.1 a., for VCR97, etc. ... **37/6**
4,000 v. 5 mA., 2 v. 2 a. **39/6**

OUTPUT TRANSFORMERS
Midget Battery Pentode 66: 1 for 3S4, etc.... **3/6**
Small Pentode, 5,000Ω to 3Ω **3/9**
Small Pentode, 8,000Ω to 3Ω **3/9**
Standard Pentode, 5,000Ω to 3Ω **4/9**
Standard Pentode, 8,000Ω to 3Ω **4/9**
Standard Pentode, 10,000 ohms to 3 ohms... **4/9**
Multi-ratio 40 mA., 30:1, 45:1, 60:1, 90:1, Class B Push-Pull **5/6**
Push-pull 8 watt 6V6s to 3 ohms **7/11**
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω... **16/9**
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω **16/9**
Push-Pull 15-18 Watts to match 6L6, etc., to 3Ω or 15Ω Speaker **22/9**
Push-Pull 20 Watts, high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω..... **39/6**
Williamson type, exact to author's specification **85/-**

WE CAN QUOTE FOR QUANTITIES OF STANDARD OR SPECIAL TYPES. S.A.E., PLEASE, WITH ALL ENQUIRIES.

LASKY'S RADIO

World Renowned for Service & Reliability



R.1155 RECEIVERS. BRAND NEW.

AERIAL TESTED BEFORE DESPATCH

These well known Ex. Air Ministry Receivers need no further introduction.

Supplied complete with 10 valves.

LASKY'S PRICE **£11 . 19 . 6**

USED MODELS **£7 . 19 . 6**

Carriage 12/6 per unit extra.

Fully Assembled Power Pack and Output Stage, for R.1155 Receiver. For use on 200-250 volts AC mains. LASKY'S PRICE **79/6** Carriage 5/- extra.

TEST PRODS. Fused, with fully retractable points. Price 4/11 per pair.

SUPERHET COIL PACKS. 3 Wavebands: 12-35 metres; 35-100 metres; 200-550 metres. Size: 4×4×3in. Price 16/-.

METAL RECTIFIERS

6 v. 1 a.	6/9
6 v. 4 a.	17/6
12 v. ½ a.	3/11
12 v. 4 a.	17/6

RF.25 UNITS. BRAND NEW AND UNUSED. For use with 1355 Receiver. Supplied with 3 new SP61 valves. 19/11. Carriage 2/6 extra.

I.F. TRANSFORMERS

Midget. 465 Kc/s. Iron dust cores in can, size:—1in. × 1in. × 2½in. high. 12/6 per pair.

WEARITE TYPE 500. Range 450-470 Kc/s. Dust cored compression trimmer tuned. In can, size:—3½in. high, 1½in. square. 12/6 per pair.

WEARITE TYPE 550. Range 445-520 Kc/s. Permeability tuned. In can, size as for 500 series. 12/6 per pair.

SPECIAL PARCEL OF MAINS DROPPING RESISTANCES. Wire wound. .1, .2, .3 amp. 12 assorted. 15/-, post free.

R1132A RECEIVERS. Brand new and unused. With all valves. Supplied in maker's original wood transit case. LASKY'S PRICE £3/19/6. Carriage 10/- extra.

P.M. LOUDSPEAKERS

All less o'trans. new and unused. First quality.

3in.	12/11
5in.	12/6
6½in.	13/6
8in.	15/-
10in.	32/6
12in.	75/-

OUTPUT TRANSFORMERS

40 mA. Multi ratio	6/11
80 mA. Multi ratio	14/11
80 mA. Pentode	12/6
60 mA. Plessey, 6,000 ohms	5/11
Standard pentode	4/11
Pentode	3/6
Midget pentode	4/3
Miniature pentode. 3S4, 1S4	4/6
PX4 Intervalve	8/6
5 : 1 Intervalve	5/11

ROTHERMEL (DEAF AID) CRYSTAL MICROPHONES.

Diaphragm driven. Extremely sensitive, can be used for tape recording, etc Miniature, size:— 1⅛in. diameter, ⅛in. thick. 7/6, post free.

TWO-GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature. With Perspex dust cover and trimmers. Size: 1½×2×1½in. ¼in. spindle LASKY'S PRICE **8/6**

No. 2. Midget. With trimmers. Size: 2½×1½×1½in., ¼in. spindle. LASKY'S PRICE **8/6**

No. 3. Midget. Less trimmers. Size: 2 × 1½ × 1½in. ¼in. spindle. LASKY'S PRICE **6/6**

No. 4. Standard type. Size: 2½×2½×1½in., ¼in. spindle. LASKY'S PRICE **6/6**

TANNOY PRESSURE UNITS

10 watts. 7.5 ohms impedance. LASKY'S PRICE **79/6** Carriage 4/6 extra.

P.A. SPEAKERS. Re-entrant horn, 10 watts, beam projector, weatherproof speakers. 7.5 ohm impedance. Horn diameter—14in. LASKY'S PRICE **99/6** Spigot mounting 10/- extra. Carriage and packing 15/- each.

AMPLIFIERS. Fully assembled and wired.

25 Watt Model. By Romac, with radio tuner, long and medium wave. 7 valves, including 2 6L6 in push-pull. Provision for high and low impedance microphone. Absolutely perfect, new and unused. For 200-250 volts 50 c.p.s. mains. LASKY'S PRICE **£25** Carriage extra. complete.

MODEL J/RA/2. 10-12 watt. A few only left. LASKY'S PRICE **£7/19/6.** Carriage 10/- extra.

4-Watt Model. Ex. Government. Complete with 10 valves: 2 25L6; 1 6H6; 1 25Z6; 6 6SK7. For operation on 110 volts AC/DC. Balance and push-pull. High, medium and low impedance inputs, A.G.C., etc. LASKY'S PRICE £7/19/6 complete. No circuits available. Carriage 10/- per unit extra.

CRYSTAL DIODES

G.E.C. Type, glass, wire ends 3/3.
B.T.H. Type, plastic..... 3/-.

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS

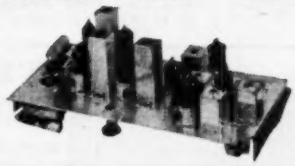
(Cathodray).

.001 mfd. 15 kV	10/-
.001 mfd. 25 kV	18/-
.0005 mfd. 25 kV	18/-
.0005 mfd. 12.5 kV	10/-

Plastic case, single bolt fixing. Other high voltage condensers.

.1 mfd. 7kV	15/-
0.04 mfd. 12.5 kV	7/6
.001 mfd. 12.5 kV	7/6

SOUND AND VISION RECEIVERS



CONSTRUCTED ON MIDGET CHASSIS

We now have in stock 3 types, including T.R.F. and 5 channel superhet models. Prices range from £6/19/6 complete. For full description write for our latest list.

10,000 VALVES IN STOCK. B.V.A., Special Purpose, Transmitting, etc. A few specials: Raytheon sub miniature CK510AY, pentode, 3/11. 954, 956, VU120, 32, 57, E1148. All at 2/6 each. RK34, 2/-; MS/PEN 3/6; VU111, 3/6. Sylvania (red) EF50, 12/6.

EXTENSION SPEAKERS. 3in. P.M. Complete with cabinet. Medium walnut veneer. Modern and pleasing design. Ideal for radio extension and intercom. slave units. Fitted with back. PRICE 21/-. Postage 2/- extra.

ELECTROLYTIC CONDENSERS

8 mfd. 450 v.w.	2/3
8 mfd. 500 v.w.	2/11
16 mfd. 350 v.w.	2/6
16 mfd. 500 v.w.	3/6
32 mfd. 500 v.w.	4/11
50 mfd. 350 v.w.	3/11
60 mfd. 350 v.w.	3/11
250 mfd. 12 v.w.	2/-
250 mfd. 350 v.w.	4/11
8+8 mfd. 450 v.w.	4/6
8+16 mfd. 500 v.w.	4/11
12×12 mfd. 350 v.w.	3/6
16+16 mfd. 500 v.w.	4/6
16+24 mfd. 450 v.w.	5/11
32+100 mfd. 450 v.w.	7/6
60+100 mfd. 350 v.w.	9/6
BIAS	
25 mfd. 25 v.w.	1/6
50 mfd. 12 v.w.	1/6
50 mfd. 50 v.w.	1/6
75 mfd. 12 v.w.	1/-

ALL BRAND NEW AND GUARANTEED (NOT EX-GOVT.)
All other types, Paper, Tubular, Waxed, etc., in stock.

INTER-COM. SETS

4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet.

Suitable for use as baby alarm.

MASTER UNIT £7/15/-. Carr. 5/- extra.

Extension Units. As Illustrated. **£1/1/-.** Carriage 2/- each extra.

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(Opposite Paddington Hospital) *Telephones:* CUNningham 1979 and 7214.

MAIL ORDER & DESPATCH DEPARTMENTS, 485/487 Harrow Road, Paddington, London, W.10.

Terms: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

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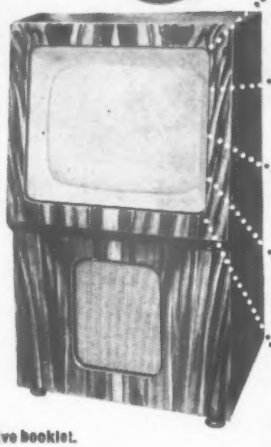
"World Renowned for Service & Reliability"

Introducing the

TELE-KING

laboratory developed

16"



A practical 5-channel

SUPERHET TELEVISION RECEIVER

Using the new 16-inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

6/- POST FREE

ALL COMPONENTS IN STOCK. WRITE FOR LIST.

CHASSIS
Power pack; Sound-vision and Scan chassis. PRICE 15/- each. All other metal-work available from stock.

COILS
13 All exactly as specified. PRICE £2/14/3.

RESISTANCES
72 Resistances, all exactly as specified, 18/-.

CABINET
As illustrated £8/10/0 plus carriage.

ALLEN WIDE ANGLE COMPONENTS

DC.300 Coils	£2 2 0
GL.16 Coil	10 0
GL.18 Coil	10 0
Focus Coil	£1 15 0
FO.305 trans.	£1 1 0
Frame B.O. transformer	15 0
Line EHT. transformer, 10-16 Kv. L.308	£2 10 0

WIDE ANGLE CATHODE RAY TUBES

14in. rectangular	£21 5 8
17in. rectangular	£26 19 8
16in. round metal cone ion trap tube	£24 6 5

Carriage and insurance extra.

Variable Inductance Width Control, 3/6. Plessey Width Controls, 6/6.

C.R.T. Rear Neck Protectors, 2/6.

C.R.T. MASKS. Brand new

LATEST ASPECT RATIO

10in.	7/6
12in.	15/-
12in. flat face,	15/-
14in. rectangular	21/-
16in. Double-D	31/6
17in. rectangular	27/6

SOILED OLD ASPECT RATIO

9in. sorbo	5/-
12in.	7/6
12in. with fitted armour plate glass (new ratio)	11/6.

ARMOUR PLATE GLASS

15in. Actual size 18½in. × 19½in. × ⅛in.	7/11
12in. Actual size 13in. × 10½in. × ⅛in.	4/-
9in. Actual size 9in. × 8in. × ⅛in.	3/-

DARK SCREEN FILTERS (LATEST TINT)
12½in. × 14½in. For 16 and 17in. c.r. tubes, 25/-. 11in. × 13½in. For 9, 10 and 12in. c.r. tubes, 15/11.

USED CATHODE RAY TUBES
For Callers Only. These tubes have either heater—cathode shorts and/or ion burns. Ideal for experimental and testing purposes.

9in.	35/-
10in.	45/-
12in.	55/-

Line EHT Transformer, with EY51 heater winding, 12/6.

Focus Magnet. With Vernier Control. For any type c.r. tube with 35 mm. diam. neck, 21/6. Less Vernier, 15/-.

Multi-Ratio Frame Output Transformer, 10/6.

Scanning Coils. High impedance frame, low line, 12/6. Plessey. Low impedance line and frame, 25/-.

METAL RECTIFIERS.

WX3 and 6. Each	3/9
14D36	11/8
14A86	20/4
36EHT45	23/8
36EHT50	26/1
36EHT100	29/6

LATEST 12in. PLASTIC MASK
Incorporates gold finish tube escutcheon and dark screen filter. Overall dimensions: 13½in. wide, 10½in. high.
17/6d. Post 2/6 extra.

W/B & PLESSEY

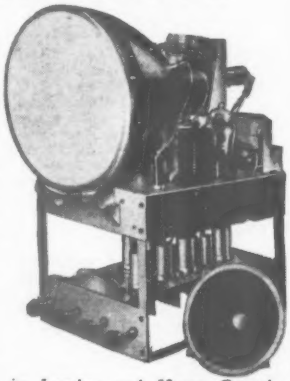
Line EHT trans.	32/6
Frame trans.	25/6
3 Mc/s boost choke	5/9
Width control	10/-
Scanning coil	33/3
Main choke	15/6
Focus ring	22/6
Heater trans.: WB/103	42/-
WB/103A	52/6
Front and rear C.R.T. supports	21/6

COILS
All models available including filter chokes. Wenvoe, Kirk o'Shotts, Holme Moss, Sutton Coldfield, 28/- per set. Alexandra Palace, 20/- per set. L9 RF choke, 2/-.

CHASSIS
Sound-Vision, 18/6. Power-Pack/Time base, 18/6.

Support for S.V. chassis, 6/-.

THE VIEWMASTER

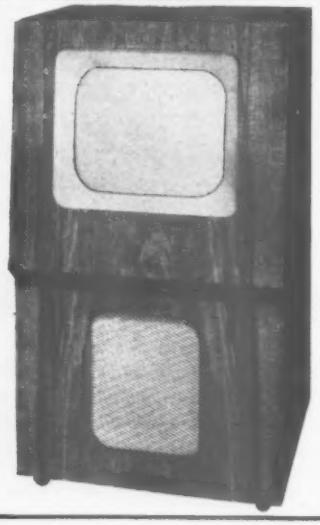


The television set you can build at home from standard parts.
Wenvoe, Kirk o'Shotts, Holme Moss, Sutton Coldfield and Alexandra Palace operation. Brilliant high definition black and white picture.
Superb reproduction.
Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.
Incorporates all the latest developments.
Television for the home constructor at its finest.
Send to-day for the CONSTRUCTION ENVELOPE, 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions. Model "A" for use in London and Home Counties. Model "B" for use in Sutton Coldfield Area. Model "C" for Holme Moss. Model "D" for Kirk o'Shotts. Model "E" for Wenvoe.

PRICE Post free **7/6** per copy.

ALL COMPONENTS IN STOCK AND SOLD SEPARATELY.

DE LUXE TELEVISION CABINETS



For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster. "Practical Television," "Practical Wireless," and "Wireless World" televisors.

LASKY'S PRICE **£8.10.0**

Carriage 12/6 extra.

Outside dimensions of cabinet 17½in. × 16½in. × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

This cabinet can also be supplied cut out for a 16in. C.R. tube.

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370 HARROW ROAD, PA

(Opposite Paddington Hospital) *Tele*

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A PORTABLE TAPE RECORDER

NOT A KIT

BUT A FACTORY BUILT JOB. By a well-known manufacturer. Simple to operate. Finest quality components throughout.

LASKY'S RADIO
World Renowned for Service & Reliability

BRAND NEW—UNUSED—COMPLETE

- ★ Attractive carrying case.
- ★ Twin track recording.
- ★ Instant playback.
- ★ Size of case: 17 × 12 × 7in.
- ★ Total playing time of 66 mins.
- ★ 6 Valves.
- ★ Weight 31 lbs.
- ★ A.C. mains 200-250 v.
- ★ Fast rewind.
- ★ Record level indicator.
- ★ Complete. Ready to switch on.

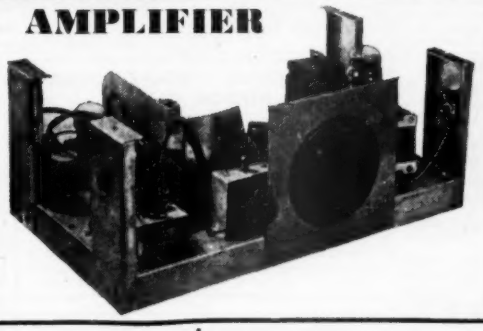
MAKE NO MISTAKE— YOU MUST SEE AND HEAR THIS

LASKY'S PRICE
£34.19.6
Carriage and insurance 15/-

Supplied fully assembled and wired, with all valves, 1200ft. spool of tape, take-up spool, crystal hand microphone, instruction book, and circuit diagram.

THE RECORDING AMPLIFIER

As used in the recorder above. 6 valves, 2 6V6, 2 6J7, 1 6J5, 1 5Z4. Supplied fully assembled and wired, with all valves and 5in. speaker. Ready for use, 200-250 volt A.C. mains. Size:—15½in. wide, 8½in. deep, 6in. high. Circuit available.



LASKY'S PRICE
£8.19.6
Carriage and insurance 10/- extra

PORTABLE CABINETS

As illustrated. Can be supplied separately.

LASKY'S PRICE £3.15 Carriage 10/- extra.

TAPE RECOMMENDED
Scotch Boy
1,200ft. Reels 35/-
600ft Reels 21/-

MICROPHONES. CRYSTAL
Rothermel 59/6.
Acos No. 1 £6/6/-.
Acos No. 2
Complete with stand £6/6/-.
Lustraphone. Moving Coil. Stand type. £5/12/6.
Lustraphone. Moving Coil. Hand type. £5/5/-.

MICROPHONE STANDS

Table model. 2 section Chrome plated. Crackle finish base. 19/6.

Floor model. 2 section. Brass, heavily chrome plated. 89/6. Carriage 2/6 extra.

4-WATT AMPLIFIERS

Ex-Government. Complete with 10 valves: 2 25L6, 1 6H6, 1 25Z6, 6 6SK7. For operation on 110 volts AC/DC. Balance and push-pull. High, medium and low impedance inputs. A.G.C., etc.

LASKY'S PRICE £7.19.6 Complete
Carriage 7/6 extra.

RADIO

ow Road) Ltd.,
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TERMS: Pro Forma, Cash with order, or C.O.D. on post items only. Postage and package on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in trasnit.

10,000 VALVES IN STOCK

B.V.A., Special Purpose. Transmitting, etc.
Write for our latest list.

A few Specials:
Raytheon Sub-Miniature, CK510AY, Pentodes, 3/11.
954, 956, VU120, 32, 57, E1148. All at 2/6 each.
RK34, 2/-: MS/PEN, 3/6: VU111, 3/6.
Sylvania (red), EF50, 12/6.

BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE

You're SURE to get it at

STERN'S

ESTABLISHED 25 YEARS

A MIDGET 4-STATION "PRE-SET" RECEIVER

A complete Kit to build a 4-station "Pre-set" Superhet Receiver for A.C. mains operation.

The set is designed to receive any three stations on medium waveband and one on long wave, each station being received by the turn of a rotary switch—no tuning being necessary. It is of midget size, being 8¼in. × 4½in. × 7in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price. This Receiver, as illustrated, can be completely built for approx. **£9/9/-**. The complete assembly instructions, including component layout and component price list, are available for **1/9**

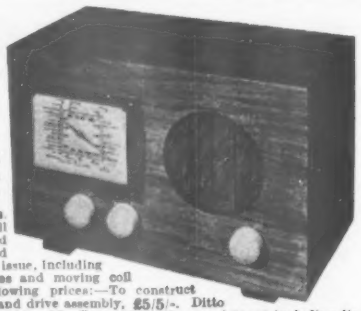
A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.

Designed to operate on A.C. mains 200/240 volts, or by an "Alldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied (a) as an "Alldry" Battery Superhet Personal Set which can then be accommodated in the attache case as illustrated (size 9½in. × 4½in. × 7in.), this is attractively finished in lizard, maroon, dark green or blue rexine, or (b) as a combined Mains/Battery Superhet Portable Receiver, for which a polished wood cabinet is available to accommodate both Mains Unit and Batteries together.

Circuit incorporates delayed A.V.C. and pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound frame aerials, fully aligned I.F. transfs. and drilled chassis, etc. Overall size of assembled chassis 8in. × 4in. × 2¾in. This receiver, as illustrated, can be completely built for approx. **£10** (plus Mains Unit if required). Send **1/9** for the fully descriptive Assembly Book which includes Practical Layouts and complete price list of Components.

The "Wireless World" 3-Valve Set



A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands. We are able to supply all of the components to build this set, as designed and specified in the Feb. 1950 issue, including the drilled chassis. Valves and moving coil speaker, etc., at the following prices:—To construct complete chassis, less dial and drive assembly, **£5/5/-**. Ditto including dial and drive assembly, **£6**. To construct the complete set, including dial and drive assembly and cabinet, **£7/3/6**. Overall size of cabinet is 7¾in. × 3¾in. × 11¼in. A reprint of the designer's article, giving circuit and assembly instructions (this is available separately for **9d.**) together with a practical component layout is included with each of above assemblies.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build Midget "Alldry" Battery Eliminator, giving approx. 69 volts and 1.4 volts. This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 69 volts.

The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4¾in. × 1¾in. × 3¾in. Price of complete Kit with easy-to-follow assembly instructions, **42/6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled unit 7in. × 2¼in. × 1¼in. Price **47/6**.

THE "MINI-TWIN" 1-VALVE BATTERY SET

A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption.

Drilled chassis and practical diagrams make it the ideal set for the beginner to build.

The complete chassis, including valve, can be built for **37/6**, the attractive plastic case is **9/6**, and suitable headphones **14/9**.

The complete assembly instructions, layouts and a component price list, are available for **1/6**.

This Receiver also performs excellently, without modification, as a tuning unit, and in addition, with simple modifications for which a complete diagram is provided, makes a first-class pre-amplifier for pick-up or microphone.

TWO BATTERY PORTABLES

(a) THE "MINI TWO-THREE"

An "Alldry" Battery Portable of midget size, 6¾in. × 4¼in. × 3¾in., designed to cover medium waveband 190-559 metres, with use of short trailer aerial.

The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.

Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain ouput pentode. Valve line up 1T4—1T4—DL94.

The 2-valve set can be completely built for **£4/3/6** (less case), and the 3-valve for **£5/3/-** (less case). Each price includes valves, speaker and drilled chassis.

Send **1/9** for the assembly instructions; they include simple and complete practical component layouts and diagrams, which enable the most inexperienced constructor to successfully build either set. All components are available for separate sale, a price list being supplied with assembly instructions.

(b) THE "MINI-FOUR"

A 4-valve Battery Superhet Receiver designed to receive 4 pre-set stations, three on medium waveband and one on long wave to suit local conditions. Each station is obtained on the set by the turn of a rotary switch. No tuning is necessary.

It is of midget size, being only 4¼in. × 6¼in. × 4¼in. when completely built and is very easily assembled from diagrams supplied.

Cost of all components to build this set, in accordance with the design, including a drilled and cut chassis and panel and new valves, is **£9/10/-** (or less valves for **£6/7/6**). Attractive carrying case finished in blue leatherette, **16/9**. Complete constructional data with a blue print, which shows the practical component layout and wiring diagram, together with an individual component price list, is available separately, **1/6**. Our battery eliminators (illustrated above) available in kit form are suitable for use with this set.

THE FAMOUS "SHAFTESBURY" RIBBON MIKE

Incorporating internal line transformer having transformation ratio from ribbon impedance up to 500-600 ohms . . . reduced from 10 gns. to **£6**. A special line to grid, 500-600 ohms transformer also available for **25/-**.

DENCO I.F. LINER

For accurately giving 465 Kc. and 1.6 Mc. I.E. channels and associate circuits. Battery operated, small and completely self-contained, **59/6** (plus battery 2/2).

THE "WIRELESS WORLD" MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including valves and moving coil speaker, for **£3/10/-**, including designers' complete building instructions (these are available separately for **9d.**).

THE VIEWMASTER TELEVISOR

We have had very considerable experience in assisting customers to build this T/V and can supply a SPECIFIED COMPONENTS EX-STOCK. The assembly instructions showing practical layouts and price list are available for **7/6** for London, Sutton Coldfield, Holme Moss, Kirk-o'-Shotts and Wenvoe. Complete television price list is contained in our general STOCK LIST at **9d.**, including Haynes, etc., components.

THE DENCO ULTRA MIDGET SUPERHET COIL TURRETS WITH A ROTARY TURRET ACTION

Type CT9 consists of a four station "pre-set" unit from which any three stations on medium waveband and one on long wave can be received by a turn of the turret switch. Price **42/10**.

Type CT10, is a 3 waveband coil pack incorporating a fourth switch position for Gram. Complete coverage is, long waveband 700-2,000 metres, medium waveband 190-570 and short wave 15-50 metres. Price **£2/12/-**.

A complete receiver circuit and all necessary data is included with each turret. These can be supplied separately for **6d.**

COMPLETE BATTERY CHARGER KIT

For charging either 2, 4, 6 or 12 volts at 1½ amps. Complete in metal case, and incorporating a limiter resistor. Size 5½in. × 5½in. × 4½in. Complete and ready for use, **52/6**.

ELECTRIC TRAIN CONTROL UNIT

Provides 4, 6, 8, 10 or 12 volts 1 amp, and has provision for forward and reverse motion. Complete in metal box. Size 5½in. × 5½in. × 4½in. **53/6**.

PICK-UPS

Cosmocord "G.P.20," for standard records, **£3/11/5**; interchangeable (G.P.19) head for L.P. records, **£2/3/4**.
Decca lightweight "turnover head" type, for L.P. and standard records, **£3/19/2**.
Goldring, Standard, lightweight Magnetic, **35/10**.
Cosmocord "Acos" G.P.30, turnover crystal type. For Standard or L.P. Records, **£3/11/5**.

BATTERY CHARGER KITS

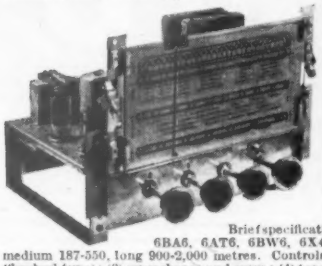
All kits incorporate metal rectifiers and are for use on A.C. mains 220-250 volts. All kits include an easily followed wiring diagram.

For charging 6 or 12 volt battery at max. 1½ amps. with variable resistor and meter, **£2/14/-**.
For charging 6 or 12 volt battery of max. 2½ amps., less variable resistor and meter, **£2/2/-**.
For charging 6 or 12 volt battery at max. 2½ amps., with variable resistor and meter, **£3/8/3**.

Send 9d. for our New MARCH STOCK LIST, it shows hundreds of **RADIO AND TELEVISION COMPONENTS** and many KITS OF PARTS for both Sets and Battery Chargers. When ordering please include approx. cost of Post and Packing.

TWO COMPLETELY ASSEMBLED "ALL-WAVE" SUPERHET CHASSIS

(a) **MODEL B.3.** A 5-valve 3-waveband superhet Receiver.
(b) **MODEL B.** A 5-valve 6-waveband (4 bandspread) Superhet Receiver.
Both Receivers are for operation on A.C. mains 100/200 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent, clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram," etc.



Brief specifications: **Model B.3.**—Valve lineup, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage, short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel-type); (3) wavechange and gram; (4) tone (3-position switch operative on gram and radio).
Negative feedback is employed over the entire audio stages. Chassis size: 11 × 7¾ × 8¼in. high. Dial size: 9¼in. × 4¼in. Price, complete and READY FOR USE, excluding speaker, **£12/12/-**. (Carr. and Pkg. 7/6 extra).

Model B employs a similar valve line up as the B.3, but covers 6 wavebands. Short wave 11-16, 16-25, 22-33, 31-46 and 43-120 metres, and medium wave 187-550 metres. The first four short bands are bandspread. The controls employed are as used on the B.3 model, but the tone control operates a six-position switch, having three additional positions for varying bass and treble on gram reproduction. Negative feedback is employed over the entire audio stage. Size of chassis and dial is as given for B.3. Price complete and READY FOR USE, excluding speaker, **£15/15/-**. Carriage, packing and insurance 7/6 extra.

MODERNISE YOUR OLD RADIOGRAM FOR £26

with the very latest equipment. We will supply the 3 waveband chassis on the left with the Plessey auto changer on the right, complete with 10" speaker for **£26** (**£29.15.6** with the 6 waveband chassis). This is less than half the price of comparable commercial three speed auto radiograms.

A GENUINE SPECIAL OFFER!

PLESSEY 3-SPEED AUTO CHANGE UNITS

Brand New in maker's Cartons, complete with mounting instructions.

£11-19-6

(Normal price is £23/10/-)

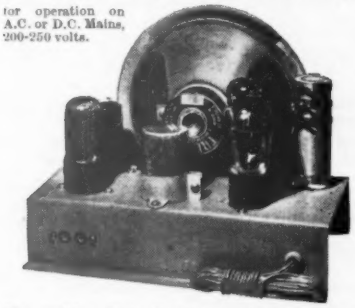
- These units will auto change on all three speeds, 7in., 10in. and 12in
- They play MIXED 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- The size of the unit deck is 14in. x 10½in. with 6in. above deck and 2½in. below.

A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

Please add 7/6 packing, carriage and insurance.

A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER

for operation on A.C. or D.C. Mains, 200-250 volts.

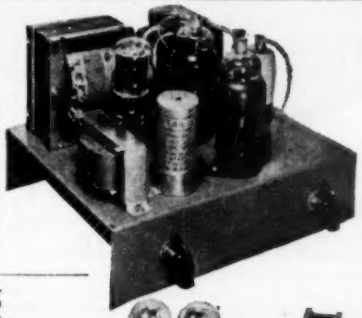


This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.
A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. × 5in. × 7in. and valve line up 25Y5-6aH7-25L6.
Price of complete kit, including drilled chassis and valves, **£4/2/6**, plus 6in. P.M. (which fits on chassis), **16/-**, or 8in. P.M., **18/9**.
Price of fully assembled chassis ready for use, **£5/5/-** (plus cost of speaker).
Copy of assembly instructions and components price list available for **1/3**.

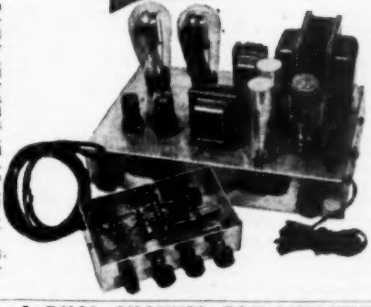
!! AMPLIFIERS !!

TWO COMPLETE KITS OF PARTS

A 6-8 watt QUALITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, incorporating a simple arrangement to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers.
The overall size of the assembled chassis is 10in. × 8in. × 7½in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, **£6/17/6**. Price of assembled chassis, supplied ready for use, **£8/12/6**. Full descriptive leaflets are available separately for **1/-**.



A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote controlled Preamplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7 × 4 × 2in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV., 6.3 volts at 2 amps and 30 mA H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, **£14/-/-**. Complete specification and layout, **2/-**. We can also supply completely assembled and ready for use at **£17/-/-**.
THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THE COST.

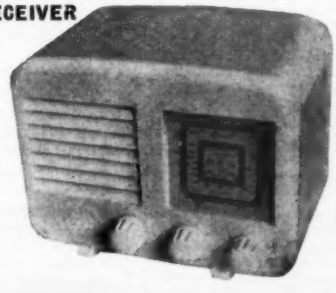


A 5-VALVE "ALL-WAVE" SUPERHET RECEIVER

For use on A.C. Mains 200 to 250 volts.
This small attractive Receiver, embodying modern circuit technique, is designed to cover Short, Medium and Long wavebands, and incorporates the following outstanding features:

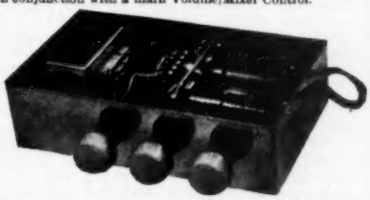
- A superhet circuit designed for high efficiency on all three wavebands.
- A 3½in. P.M. Speaker accurately matched for good quality reproduction.
- The latest range of new 6-volt B.V.A. miniature valves.
- Built-in frame aerial with provision for external aerial for distant stations.
- A white plastic cabinet of very attractive appearance overall size 7½in. × 5½in. × 5½in.
- THE RECEIVER AS ILLUSTRATED CAN BE BUILT FOR APPROX. **£10/10/-**.

Send 2/6 for the fully descriptive stage by stage assembly and wiring diagrams, with which complete price details are given.



A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive **PRE-AMPLIFIER** and **TONE CONTROL UNIT** provides a full control of bass and treble in conjunction with a main Volume/Mixer Control.



It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long playing, without recourse to pick-up correction.
The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier.
Response characteristics are given in 12-watt amplifier advt.
The unit measures only 7in. × 4in. × 2in., including self-contained power supply, and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (6SN7 and GJ5), **£3/16/9**. Complete assembly data is available separately for **1/-**. Completely assembled and ready for use, **£5/5/-**.

STERN RADIO Ltd.

109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

GARLAND

GARLAND UE7B RECORD PLAYBACK AMPLIFIER
A revised version of our popular amplifier designed to suit Truvox Tape Desk or Lane Tape Table. New features include higher gain, magic eye record level indicator, and smaller size for incorporation in portables. Oscillator and power supplies included. Standard valves throughout. Formica control panel. Supplied complete with 8in. P.M. loudspeaker. Price £13/2/6, plus 7/6 carriage, etc. Trade supplied.

GARLAND ACIV AMPLIFIER (C)
Providing exceptionally wide frequency response and low harmonic distortion at a maximum output of 11.5 watts. High and low gain inputs with bass, treble and volume controls. Standard valves throughout, 15 gns., plus 15/- carriage, etc.
GARLAND KIT for ACIV, £13, plus 15/- carriage, etc.

AMPLIFIER ACII (C)

Incorporates volume and tone controls, providing 4 watts output. H.T. and L.T. supplies are from mains transformer. Standard valves throughout. Amplifier wired and tested, £6/2/6, plus 5/- carriage.
GARLAND KIT for ACII, £5/2/6, plus 5/- carriage.

HIGH-QUALITY AMPLIFIERS (C)

LEAK "Point One" TL12/12 watt, **27 guineas.** LEAK RC/PA/U remote control pre-amplifier, **9 gns.** LEAK "Varislope" pre-amplifier, **12 gns.** ACOUSTICAL QUAD 12-watt Amplifier (including pre-amplifier), **£35.** ROGER'S "WILLIAMSON" AMPLIFIER, **£31.** ROGERS "WILLIAMSON" PA/TC/UNIT, **£10/7/6.** ROGERS "RD BABY DE LUXE," including pre-amplifier, **£18.** ROGERS "JUNIOR DE LUXE" 10 watt, **£26/10/-.** ROGERS "MINOR" 4 watt, **£11.**

GARLAND PORTABLE RECORDER TYPE LU7B

41 GNS
Carriage &c. 10/-

A three-motor, six-valve recorder, with twin-track facility enabling up to one hour's recording time from one 1,200ft spool of tape. Recordings can be made from radio, pick-up or microphone. Good quality reproduction is ensured by the specially designed amplifier system and the high flux 8in. P.M. speaker. The recorder incorporates automatic electronic erasure, fast forward and rewind, and positive action servo brakes in all positions. Tape speed is 7½in. per second. A magic-eye is provided for record-level indication. The recorder is supplied complete with filter-cell microphone, a 1,200ft reel of tape and a spare spool, and is housed in a handsome case finished in an attractive vinyl plastic.
Dimensions: 20in. x 13in x 12in. Weight, 30 lbs.

TAPEMASTER MAGNET RECORDING HEADS

A new range of high-quality tape recording heads in chromium-plated cases for single hole fixing. All types are designed for half track recording. Senior Record/Playback, 5,000 ohm, 45/-. Junior Record/Playback, 3,000 ohm, 39/6. Senior Erase Head, 45/-. Junior Erase Head, 39/6.
TAPEMASTER OSCILLATOR UNITS to suit these heads, 45/-.
TAPEMASTER OSCILLATOR COIL, 10/6.

LANE TAPE TABLE
Latest model incorporates three motors; fast wind-on and rewind; automatic braking; high impedance half-track heads; hub locking device; tape speed, 7½in per sec. **£16/10/-.** Carriage, etc., 10/-.

TRUVOX TAPE DESK MARK III
Twin-track 7½in. and 3¾in per sec. push-button operated. **£23/2/-,** plus 10/- carriage, etc. **GARLAND RP8 AMPLIFIER:** 6-watt push-pull record playback amplifier for use with above tape desk. **£19/19/-,** plus 10/- carriage, etc. See previous advts. or send 2½d. stamp for details.

RECORD PLAYERS (C)

COLLARO RC511 single-speed Autochanger. Magnetic, price **£11/14/11,** incl. P.T. Crystal price **£12/3/2,** incl. P.T.
COLLARO 3/RC511 3-speed Autochanger with two heads, **£18/14/1.**
B.S.R. MONARCH 3-speed Autochanger with reversible pick-up, price **£17/17/-.**
GARRARD RC.75 3-speed Autochanger, **£16/6/6.**
COLLARO AC47 single-speed turntable and motor. Centre driven by heavy induction motor. Price **£6/13/4,** incl. P.T.
COLLARO AC514 Record Player. Single speed rim-drive with pick-up. Price **£6/19/-,** incl. P.T.
B.S.R. single-speed motor and turntable MU.15. Price **£3.** Fitted in portable bakelite cabinet, **£4/10/-.**
DECCA 3-speed Gram. motors. Price, incl. P.T., **£6/8/6.**
DECCA Turnover Pick-up for use with above motors. Price, incl. P.T., **£3/19/4.**
ACOS G.P.20 Standard or long playing, price **£3/11/5.** Spare heads, **£2/3/4.**
B.S.R. GRAMOPHONE UNITS. 3-speed motor with pick-up, mounted on plastic playing table. Price **£9/19/11,** including purchase tax.

TAPE RECORDER OSCILLATOR COILS
Inductance 6.3 mH, giving frequency of 45 Kc/s with a .002 mfd. condenser. For use with high impedance heads. Made for us by a leading manufacturer. Price **6/9** each. *Trade supplied.*

SCOTCH BOY MEDIUM COERCIVITY TAPE
We recommend this tape for use with ALL GARLAND Tape Recorders. Now available in the following lengths. 1,200ft., **35/-**; 600ft., **21/-**; 300ft., **12/3.** Spare 7in. spools (1,200ft.) **4/3.**

CONNOISSEUR 3-SPEED TRANSCRIPTION QUALITY GRAMOPHONE MOTOR AND TURNTABLE
Full 12in turntable, 33⅓, 45 and 78 r.p.m. The synchronous motor is virtually vibrationless and suitable for standard, transcription and micro-groove recordings. Including P.T., **£23/13/-.**
CONNOISSEUR. Super lightweight pick-up with interchangeable heads for standard or micro-groove recordings, fitted with easily replaceable semi-permanent sapphire. Price complete with two heads, **£10/0/8.**

GARLAND OSCILLATOR UNIT
For magnetic recording. Incorporating 6V6G valve and Garland Oscillator coil and supplying H.F. bias and erase for high impedance heads. Price **£2/2/-,** plus 2/6 post. Trade supplied.

CLEAREX TELEVISION MAGNIFYING LENS

9in. clear, **55/-**; 9in. filter, **60/-**; 12in. clear, **75/-**; 12in. filter, **80/-**; Carriage and packing 5/- each on all types. **(C.)**

HIGH QUALITY LOUDSPEAKERS
Suitable for use with reproduction equipment mentioned on this page.
GOODMANS Audiom 60, 12in, **£11/5/-.**
GOODMANS Axiom 150 Mk. II, 12in, **£14/3/4.**
WHARFEDALE Bronze 10in, **£5/0/4.**
WHARFEDALE Golden 10in, **£8/6/-.**
WHARFEDALE Golden 10in CSB, **£9/5/-.**

BROS, Ltd.

I.F. TRANSFORMERS. Small size, 2½in. x 1½in. x 1in., 13/6 per pair. Made for us by a leading manufacturer.

UNDRILLED CHASSIS. In 20 s.w.g., bright mild steel: Four-sided size 13in. x 7in. x 2½in., 7/6 each; two-sided with two straps, 12in. x 4in. x 2½in., price 3/9 each. Two sided with two straps, size 6 x 5 x 2in., price 2/6 each.

TWO-GANG TUNING CONDENSERS. Standard size 2-gang of 500pF capacity, with fixing feet. Price 8/6.

BOOKS FOR RADIO ENGINEERS

Mullard Valve and Service Reference Manual	5/-
Mullard Amateurs Guide to Valve Selection	1/6
Osram Valve Manual, Part 1	5/-
Brimar Radio Valve and Teletube Manual	5/-
Wireless World Radio Valve Data, 3rd edition	3/6
Radio Valve Guide. By W. J. May	5/-
The Williamson Amplifier Manual, latest edition	3/6
Wireless World High Quality Amplifier Manual	2/6
T.V. Fault Finding	5/-
Television Faults	5/-
Television Explained (Miller)	5/-
Viewmaster Envelope (state transmitter for which required)	7/6
Tele-King Envelope	6/-
The Oscilloscope Book	5/-
Magnetic Recording (Quartermaine)	4/6

(Add 3d. to price in all cases for postage)

TYANA SOLDERING IRONS. Light weight, 40 watt irons with easily interchangeable elements and 3/16in. diameter bits. Voltage ranges, 100/110 v., 200/220 v. and 230/250 v. Price 16/9. "The iron that makes soldering a pleasure."

CERAMIC SWITCHES. Single pole, eight-way, 3/6 each.

J.B. SQUAREPLANE DIALS. Printed in two wavebands with station names. 8/1 drive and bronze escutcheon and glass. Price 12/9.

J.B. FULL VISION DIALS. Similar to above but with 7½ x 3½in. dial printed in three wavebands. Price 13/-.

DECALS. 500, ¼in. high white transfer letters and words for marking electronic equipment. Price 4/9 per book.

WIRE WOUND RESISTORS. Open, cement coated or vitreous enamelled. **4 watt,** 21, 50, 90, 100, 200, 1 k. Price 1/- each. **6 watt,** 30, 145, 250, 270, 10 k., 15 k. Price 1/6 each. **10-15 watt,** 5, 90, 100, 120, 170, 175, 200, 250, 400, 500, 600, 700, 750, 950, 1 k., 1,690, 3.5 k., 3.6 k., 4.5 k., 4.7 k., 11 k., 15 k., 20 k., 25 k., 47 k., 50 k., 1/9 each. **15 watt,** 650 ohm. Price 2/-.

HIGH CAPACITY PRECISION MICA CONDENSERS. We have still a few thousand of these left, but as we can no longer offer our original comprehensive range, we are clearing the balance, in the values shown hereunder, at 1/- each, or 9/- per dozen. Accuracy in all cases is plus or minus point five (0.5) per cent. Ruby mica and copper foil or silver. (a) 0.017970μF, 1/3, (b) 0.023570μF, 1/3, (bl) 0.027400μF, 1/6, (d) 0.040710μF, 1/6, (dl) 0.048010μF, 1/6, (e) 0.055820μF, 1/6, (fl) 0.082910μF, 1/6, (g) 0.087460μF, 1/6, (h) 0.103435μF, 1/9, (i) 0.123750μF, 1/9, (j) 0.147000μF, 1/9.

ALL GOODS NEW AND UNUSED. **ITEMS (C) REQUIRE CRATING FOR SAFE DESPATCH. CRATES ARE NOT CHARGED PROVIDED YOU UNDERTAKE TO RETURN CARRIAGE PAID TO US. PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND ADDRESS.** POST ORDERS TO OUR DEPTFORD ADDRESS. EARLY CLOSING THURSDAY, OPEN ALL DAY SATURDAY.

CARBON RESISTORS

ONE-THIRD TO ONE-HALF WATT: 10, 13, 15, 22, 33, 39, 56, 68, 71, 73, 100, 150, 170, 180, 220, 250, 270, 330, 390, 400, 450, 470, 500, 530, 600, 680, 820, 1k, 1.2k, 1.5k, 2.2k, 3.3k, 3.9k, 4k, 4.7k, 5.6k, 6.2k, 6.8k, 7.5k, 8.2k, 10k, 12k, 15k, 18k, 20k, 22k, 24k, 25k, 27k, 30k, 33k, 39k, 40k, 47k, 50k, 56k, 100k, 150k, 220k, 270k, 330k, 470k, 680k, 1m, 1.2m, 1.5m, 2m, 2.2m, 2.7m, 3.3m, 4.7m, 10m. All at **4d.** each.

ONE WATT: 50, 56, 82, 120, 150, 240, 330, 290, 680, 1k, 1.5k, 2.2k, 3k, 3.9k, 4.7k, 5.1k, 5.6k, 6.8k, 10k, 12k, 18k, 22k, 24k, 27k, 33k, 68k, 70k, 80k, 170k, 330k, 390k, 470k, 680k, 750k, 1m, 2.2m. All at **6d.** each.

TWO WATT: 220, 1k, 2k, 2.2k, 3k, 3.3k, 4.3k, 4.7k, 6k, 10k, 12k, 20k, 22k, 27k, 30k, 47k, 50k, 68k, 2.2m. All at **9d.**

FOUR WATT: 500k, 1/- each.

L.F. CHOKES. 10 Henry, 70 mA., 5/6 each

PUSH-PULL OUTPUT TRANSFORMERS. Ratio, 45 : 1 to match 6V6 etc., 10,000 ohm to 2 ohm, 4/6 each.

HIGH VOLTAGE MICA CONDENSERS 0.1μF 1,500 v. wkg. Bakelite-cased upright mtg., 3in. x 2¼in. x 1¼in. overall, 2/- each. Ceramic pot type, 10C/2178, 0.0002μF 5 kv. wkg., high H.F. current, 2/6 each. Flat bakelite-cased type, ZA2837, 0.001μF, 5 kv. A.C. test, 0.5 A. at 2-8 mc.; size 3½in. x 1¾in. x ¾in.; suitable tx or tv, 1/9 each. 0.002μF, 2.5 kv. wkg., 1/3.

METAL RECTIFIERS

Type RM2, 125 v. at 100 mA. Two in series required for mains voltage. Price 4/6 each. Type 14D/972, providing 250 v. 25 mA. when used with a reservoir condenser. Small size ideal for test equipment also in place of 14D/36 in T/V circuits. Price 6/6 each. 6 v. 1 a. half-wave (or full wave with C.T. tfmr.), price 5/- each; 12 v. 1 a. bridge, price 8/6 each; 12 v. 4 a. bridge, price 22/6.

MAINS TRANSFORMERS

All primaries 200-220-240 v.

MT1: 250-0-250 v. 80 mA., 0-4-6.3 v. 3 a., 0-4-5 v. 2 a., 21/- each.

MT2: 350-0-350 v. 80 mA., 0-4-6.3 v. 3 a., 0-4-5 v. 2 a., 21/- each.

MT3: 0-30 v., tapped to give 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., all at 2 a. The ideal model-maker's transformer, 21/-.

MT4: Charger tfmr., 0-4 v. 4 a., 10 v. 4 a., 20 v. 3 a., 21/-.

MT5: Auto: 0-10-120-200-230-250 v. at 100 w., 21/-.

137: Heavy-duty shrouded; 250-0-250 v. 120 mA., 6.3 v. 7 a., 5 v. 5 a., 37/6.

190: Heavy-duty shrouded; 350-0-350 v. 120 mA., 6.3 v. 5 a. C.T., 5 v. 5 a., 39/6.

POTENTIOMETERS
Ex-govt. or Manufacturers Surplus

Value	Track	Wattage	Spindle length	Price
33	Carbon	1	1in	2/6
50	W/W	5	Preset	2/6
500	W/W	5	1¼in	3/9
2.2k.....	W/W	5	Sin	3/9
3k	C/Trop	2	¾in	1/9
3k	W/W	5	Preset	2/6
5k	,,	2	¾in	2/6
8k	,,	5	¾in	2/6
10k	C/Trop	2	¾in	2/-
10k	Carbon	1	Preset	1/-
10.4k ...	W/W	5	¾in	3/-
20k	,,	3	Preset	2/-
20k	,,	5	1in	3/-
20k	C/Trop	2	¾in	1/9
25k	W/W*	5	¾in	3/-
25k	C/Mini		Preset	1/-
50k	W/W*	3	¾in	2/6
50k	C/Mini	¼	¾in	1/3
100k ...	,,	¼	¾in	1/6
200k ...	Carbon	1	¾in	1/9
1m	,,	1	2in	3/-

All new and unused. Spindle diam. ¼in. in all cases * are earthed slider.

T.R.F. COILS. Medium and long wave, aerial and H.F., 6/- per pair; with reaction winding, 6/9 per pair.

TOROIDAL CERAMIC POTENTIOMETERS. 260 Ω 50w. 6/6. 17k, 100 watt, 8/6.

TOGGLE SWITCHES. SPCO, 250 v. 2 amp. 1/9; DP on-off 250 volt, 1 amp., 2/3.

ENGRAVING TOOL. Operates from 200-240 volt A.C. for engraving on metal and plastic, price, 12/6.

FIXED CONDENSERS: (pF's): Ceramic: 2, 4, 15, 20, 27, 30, 50, 220, 350. All at **9d.** 1,000pF. 1/-. Silver Mica: 10, 30, 50, 160, 170, 180. All at **6d.** 200, 300, 1,500, 8,100, **9d.** Moulded Mica: 50, 75, 100, all at **6d.** 300, 470, 1,000, 2,000, 3,000, 4,000, 4,500, 4,700, 5,000 10,000, all at **9d.**

CLOSE TOLERANCE SILVER MICA CONDENSERS. All plus or minus 1 per cent. 100pF, 400pF, **9d.** each. 1,000pF, 1,400pF, 1/3 each.

MULTI-PURPOSE TOOL. Bends, shears, punches and threads sheet-strip and rod. For all the little workshop jobs that waste your time. Complete with jig, gauge and protractor, enabling repetition work to be carried out with precision, 17/6.

VARLEY MAINS TRANSFORMERS. Primary 10-0-200-220-240 volts. Secondary 300-0-300 volt at 150 mA., 5 volt at 3 amps., 6.3 volt at 4 amps., 6.3 volt at 1 amp. Open type construction. Price 45/-.

METAL-CASED TUBULAR CONDENSERS. 0.01 mfd. 1 kV., 1/-; 0.02 mfd. 750 v., **9d.**; 0.1 mfd. 350 v., **9d.**; 0.25 mfd. 500 v., 2/-.

HEATER TRANSFORMERS. Primary 230 v., secondary 6.3 v., 1.5 amp Wax impregnated, Price 6/- each.

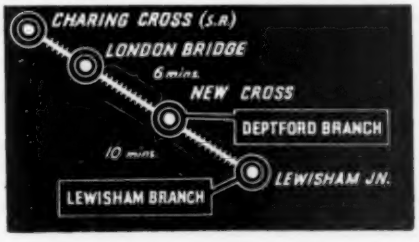
GARLAND BROS, Ltd.

CHESHAM HOUSE, DEPTFORD BROADWAY, S.E.8

Telephone: TIDEWAY 4412/3

5 OBELISK PARADE, LEWISHAM, S.E.13

Telephone: LEE GREEN 4038



RADIO TRADERS LTD.

23 WARDOUR ST., LONDON, W.1.
(Coventry Street end)
Note Phone No. GERrard 3977/8 *Grams: "Radiotrade"*

WHOLESALE, MANUFACTURERS' AND EXPORT ENQUIRIES ONLY

JONES PLUGS & SOCKETS —4, 6, 8, 10 and 12 WAY

EX. GOVT. CARBON BRUSHES—LARGE STOCKS

RESISTORS

HIGH STABILITY, close tolerances from 1% ¼, ½, 1 and 2 watts. All values up to 2 meg., including 8, 13 and 30 meg.
VITREOUS WIREWOUND. Large selection from 2 to 200 watts.
CARBON. ¼ watt to 5 watt. All popular values. Standard Car Suppressors, 15,000 ohms.

CAPACITORS

Block Paper, Silvered Mica, Mica, Tubular and Ceramic.

SWITCHES

TOGGLE, YAXLEY, OAK, ETC.

EPICYCLIC DRIVES

INDICATOR LAMP HOLDERS

Red, Green and Clear.

LAMINATIONS

RADIOMETAL 31, 39 and 40. Also many other types.

VOLUME CONTROLS

MORGANITE "H" type, "LH" type, "M" type and WIRE WOUND. Most values and popular makes in stock.

PLUGS AND SOCKETS

CINCH, PYE, JONES, BELLING & LEE, BULGIN, ETC.

TRIMMERS

Variable CERAMIC TRIMMERS. Capacities from 5 to 100 pF. Spindle and pre-set types. Also Philips trimmers and trimmer tools and many other types.

WIRES

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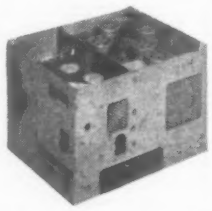
AIR MINISTRY COMMUNICATION RECEIVER R1155A. Brand New in transit cases. Frequency ranges—18.5-7.5 Mc/s, 7.5-3 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s. Complete with 9 valves and Magic Eye. Guaranteed absolutely perfect. Price **£9/10/-**, plus 10/- for packing and carriage.

1155 POWER PACK AND OUTPUT STAGE complete with U50 and KT61 valves (not surplus). Black crackle case 12×8×5in., built-in 5in. pm Speaker and phone jack. 200-250v. A.C. All connections terminate in Jones plug which enables instant operation of receiver **without any modifications whatever.** Matches in appearance with receiver. Made to "Wireless World" specifications. Built entirely from top grade new components, **£7/10/-** plus 3/6 carriage.



G.E.C. VHF RECEIVERS complete with 10 valves. Ex-Govt. Used but guaranteed excellent condition. Valves ZA2's, 954's or EF50's in HF and 1st Det. stages. Det. 19 ii local oscillator, KTW63's in three IF stages, D63 Det. and AVC, LF H63, Output KT63, Noise suppressor D63. Power requirements 6 v. 3 a., 270 v. 80 mA., as used by various British Police forces. Available in TWO frequency ranges, "B" 95.5-100 Mc/s and "C" 78.5-82 Mc/s. Oscillator Crystal controlled (No crystal included). Grey enamel steel case with lid 10×8×7in. Weight 22 lbs. Note the amazingly low price, **49/6** plus 5/- carr.

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RELAYS: POST OFFICE 3000 TYPE. 10FB/651 (1000~) 1 make, 1 break, 1 heavy duty make, 10FB/652 (120~) 2 makes, 1 break, 3 H.D. makes, 10FB/654 (6250~) 1 make, 1 break, 1 change over, 10FB/655 (1000~) 3 makes, 1 break, 1 H.D. make, 10FB/656 (1000~) 1 make, 2 H.D. makes, 10FB/965 (120~) 2 makes, 1 break, 1 H.D. make. ALL AT **5/-** each. Post paid.
SMALL MAINS TRANSFORMER COMPLETE WITH RECTIFIER. Suitable for TV, pre-amps. tuner units, and test equipment. Power supply input 230 v. 50 cps. Output 200 v. 50 mA, 6.3 v. 1.4 amps. **13/6**, plus 1/6 postage.
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Drop-thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6.**

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Semi-shrouded, drop-thro', 280-0-280, 80 mA., 4 v. 6 amp., 4 v. 2 amp., **12/6.**

Auto-wound, H.T. 280 volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separates 4 v. 3 amp., rectifier winding (upright or drop-through), **10/6.**

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Auto-transformer, various combinations of voltages including 110 v. 70 watts, and 3/4 volt windings at 1 amp., 2 volt 1 amp., drop-through or upright mounting, **10/6.**

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250-0-250, 80 mA. 6 v. 4 amp., **14/-.**

Pri. 230 v. Sec. 200-0-200 35 mA. 6 v. 1 amp., **8/6.**

Pri. 200/250 v. secondary 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps., **13/-.**

Semi-shrouded drop through 200/250 v. primary; secondary 280-0-280 250 mA., 6 v. 6 amps., 5 v. 3 amps., **29/6.** P. & P. 3/-.

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P.M. SPEAKERS (Closed field)

	with trans.	less trans.
2½in.	—	**15/6**
3½in.	—	**13/6**
5in.	**16/6**	**12/6**
6½in.	**16/6**	**12/6**
8in.	**18/6**	**15/-**

P. and P. on the above 1/- each. 10in. less trans., **25/-.** P. and P. 1/6.

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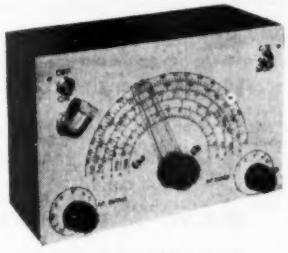
Volume Controls by famous manufacturer. Long spindle and switch, ¼, ½, 1 and 2 meg., **4/-**, each; 50 K., **3/6** each. Ganged control 3 K. and 5 K., **3/6.** ¼ and 1 meg., long spindle double pole switch, miniature, **5/-.** Post and packing 3d. each.

Trimmers, 5-40 pf., **5d.**; 10-110 10-250, 10-450 pf., **10d.**

Twin-Gang .0005 Tuning Condenser, 5/-. With trimmers, **7/6.** P. & P. 1/-.

D. COHEN

RADIO & TELEVISION COMPONENTS



KIT OF PARTS FOR SIGNAL GENERATOR. Coverage 110 Kc/s.-320 Kc/s., 320 Kc/s.-900 Kc/s., 900Kc/s. 2.75 Mc/s., 2.75 Mc/s.- 8.5 Mc/s., 8.5 Mc/s.-20 Mc/s. Metal case 10in. x 6¾in. x 4½in. size of scale 6½in. x 3¼in. 2 valves and 1 rectifier valve, A.C. mains 230/250. Internal modulation 400 c.p.s. to a depth 30 per cent. Frequency calibration accuracy plus or minus 1 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts, **£3/10/-**, P and P. 4/-. This includes the return to us for checking and calibration. We will build same for **15/-** extra. Circuit and point-to-point wiring diagram **3/6.**

WALNUT BAKELITE CABINET size 17¾ x 12 x 8in., complete with 3-wave-band scale, size 8½ x 3¼in., 5-valve superhet chassis with I.F., valve holder and transformer cut-outs, pointer, drum, drive spindle, 4 knobs, 2 scale clips, 3 pulley wheels, two brackets, scale pan and back. **DESPATCHED TO ENGLAND ONLY, 31/-,** post paid.

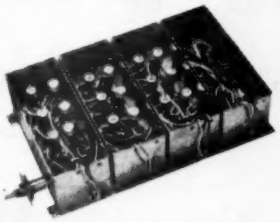
CONSTRUCTOR'S POLISHED CABINET. Size 10 x 6¾ x 5in. approx., supplied in flatted form, grooved and ready to glue together. Complete with plastic front, 3-valve chassis, size 8½ x 4 x 1½in., tuning scale, backplate and back, **10/-.** P. & P. 1/6.

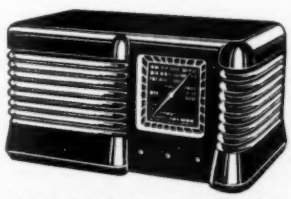
TWIN-GANG AND PAIR OF T.R.F. COILS with circuit to suit above, **8/6.**

CRYSTAL PICK-UP by famous manufacturer complete with sapphire trailer needle and volume control, **23/-.** Less volume control **21/-**, post and packing on each 1/-.

EX-GOVT. RECEIVER TYPE B28 Complete coil unit, 6 bands, 60 kc/s.-420 kc/s., 500 kc/s.-30 Mc/s., complete with 5 variable selectivity IF's (465 Kc.) B.F.O., crystal, 4-gang and circuit, **57/6.** P. & P. 3/-. Circuit sold separately, **4/-.**

Variable Selectivity IF Switch to suit above, **7/6.**





CABINET as illustrated in walnut or cream, complete with T.R.F. chassis, 2 waveband scale, station names, new waveband, back-plate, drum, pointer, spring, drive spindle, 3 knobs and back, **22/6.** P. & P. 2/6.

Gang with trimmers to suit, **7/6. Medium and long T.R.F. coils, 5/6** per pair.

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CONSTRUCTOR'S PARCEL comprising chassis 8in. x 4in. x 1½in., with speaker and valveholder cut-outs, 5in P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium, iron-cored, four valveholders, 20 K. volume control and wave-change switch. **23/-.** P. & P. 1/6.

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16 x 24 350 wkg.	**5/-**
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32 x 32 mfd., 350 wkg. and 25 mfd., 25 wkg.	**6/6**
25 mfd., 25 wkg.	**11d.**
250 mfd., 12 v. wkg.	**1/-**
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8 mfd., 500 v. wkg., wire ends	**2/6**
8 mfd., 350 v. wkg., tag ends	**1/6**
50 mfd., 25 v. wkg., wire ends	**1/9**
Ex-Govt. 8 mfd., 500 v. wkg., size 3½ x 1¾, 2 for	**2/6**
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8 mfd., 150 wkg.	**1/6**
60+100 mfd., 350 wkg.	**8/6**
50 mfd., 12 wkg.	**11d.**
32+32 mfd., min., 275 wkg.	**4/6**
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Miniature wire ends moulded 100 pf., 500 pf., and .001 ea. **7d.**

Combined 12in. mask and escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet, **17/6.** P. & P. 2/-.

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P.M. Focus Unit for Mazda tube, **15/-.** P. & P. 1/6. Similar to above with front adjustment, **2/6** extra.

P.M. Focus Unit for any 9in. or 12in. tube, 35 mm. neck, except Mazda 12in. state, tube, **12/6.**

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465 Kc. I.F.s, size 2½ x 1½in. Q.110 removed from American equipment, **5/-** per pair. Standard 465 Kc. iron-cored IF's, 4 x 1½ x 1½in., per pr. **7/6.** Wearite standard iron-cored 465 Kc. IF'S, 3½ x 1½ x 1½in., per pr. **9/6.**

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Television Masks. White Rubber, 9in. with glass, **7/6.** Cream rubber, 12in. with armourplate glass, **15/-,** plus 1/6 P. & P.

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Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquiries and Lists. S.A.E.

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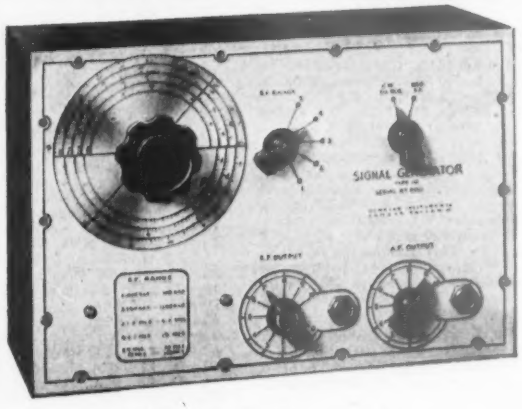

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RECEIVER S450 and S450B. Complete with valves, tuning 65/85 or 85/95 mc/s, these are ideal for Wrotham or "2" metre conversion. Housed in attractive robust grey cases measuring 12 x 4¾ x 5¾in., these contain 4 EF54's (RF, mixer, Xtal multipliers), EC32 (Xtal oscillator), 2 EF39's (2.9 mc/s IF), EB34 (det.), 6J5 and 6V6 (audio). Complete with circuit, **49/6**, post 2/-. Please state which required.

INDICATOR 182A. With VCR517 6in. tube, 3 EF50's, 4 SP61's 5U4, 9 pots, resistors, condensers, etc. Ideal for television or 'scope. New in crates (less relay). **79/6.** Less EF50's and 5U4G, **50/-.**

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Due to improvements in paper situation NOW ONLY **2/6** per copy (post 1½d.).

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TWIN RIBBON FEEDER. Heavy duty 300 ohm, **5d.** per yd. Standard K25 300 ohm ribbon, **9d.** per yd. Co-axial cable, ¼in. dia. 50 ohm, **8d.** per yd., ¼in. dia., 1/- per yd., **10/6** per doz. yds. 7ft. length ¼in. dia. Co-axial with Pye plug one end, **1/6,** post free. All other Co-axial and feeder, plus 1/6 post any length.
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TRANSMITTING TUBES. Type 813 New and Boxed **£3/10/-** each. Type 866A., **17/6** each. 3E29 (829B), **£4** each. Few only.
DEAF AID CRYSTAL MICROPHONE UNITS, 12/6 each.

SPECIAL OFFER. 300 ohm Flat Twin 150 w. rating, **6d.** per yd. (minimum 20 yds.), post free.
STANDARD ¼in. T.V. CO-AXIAL CABLE, 1/- yd. or **10/-** per doz. yds. or **9d.** yd. in 100 yd. coils. P. and p. 1/6, any quantity.

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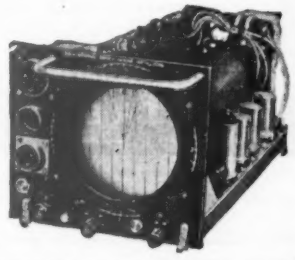
INDICATOR UNIT 62A. Containing VCR97 C.R.T., complete with mu-metal screen. Valves 12 EF50, 4 VR65 (SP61), 3 VR92 (EA50) and 2 VR54 (EB34). A large assortment of wire-wound pots, switches, H.V. condensers, resistors, etc. Built on a double deck chassis and ideal for conversion to T.V. Size 18in. x 8¼in. x 11¼in. These are in BRAND NEW condition in original transit case for only **£7/10/-**, plus 9/6 carriage.

INDICATOR UNIT 62, complete with all valves but less tube. Limited number only offered to personal callers for clearance price of **55/-** only.

INDICATOR UNIT 6E contains a 6in. C.R.T. type VCR97, 4 valves type EF50, 1 of EB34, and 1 of EA50. Easily converted to 'scope or O.K. for television. Tubes demonstrated. For callers only at **65/-**. Less tube and valves for **12/6**, plus 5/- carriage.

DISPLAY UNIT TYPE 12, contains 6in. C.R.T., Pye 45 mc/s. strip complete with 6 EF50 and EA50, and additional 8 EF50, 3 EF55, etc., etc. Would be absolutely ideal for conversion for London or Holme Moss T.V., as only additional components for power pack would be required. Brand new condition for **£9/19/6**, plus 10/6 carriage.



INDICATOR UNIT 182A, contains 3 EF50, 1 5U4G, 4 SP61, and a 6¼in. C.R.T. type VCR517. This tube will replace the VCR97 without any alteration, is completely free from cut-off and has a 'more pleasant tube colour. Contains in addition a very large assortment of pots., resistors, condensers, etc. Tubes demonstrated. Supplied BRAND NEW (less relay) for only **79/6**, plus 7/6 carriage in original transit case.

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R.F. UNITS for the R1355 supplied modified to T.V. frequency required. Any station, sound or vision for **32/6**, plus 2/6 carriage.

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COMMUNICATION RECEIVER R1155 for world-wide reception. This set is recognised as one of the finest obtainable. For those not familiar with the receiver we can supply the authoritative "Wireless World" circuit and descriptive booklet for 1/3 post paid. All our receivers are air-tested before despatch and supplied complete with 10 valves. ABSOLUTELY BRAND NEW for **£11/19/6**, plus 10/6 carriage and packing, in original transit case. Demonstration given any time. Come and hear the receiver you buy.
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STANDARD MAINS TRANSFORMER. Primary 200/230/250 volts 50 cycles. Sec. 325-0-325 volts 70 m/a., 6.3 volts 2.5 amps., 5 volts 2 amps. Half shrouded, drop through with mains panel size 4in. x 3¼in. Brand new at **12/6** each, plus 1/6 post.

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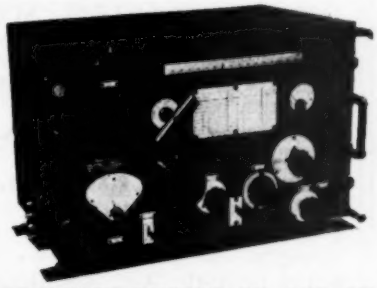

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RCA AR77E receiver in perfect order **£37.10. RCA** AR88LF **£65. HALLICRAFTERS** SX28 receiver **£55.** SX24 **£30.** S20, S20R. **EDDYSTONE** 640 receiver, as NEW, **£22.10.** S740 **£30.** S750 **£50.** Marine **£45. MARCONI** CR100 receiver, reconditioned, from **£27. HAMMARLUND** HQ129X with matching speaker, NEW, **£85. NATIONAL** HRO receivers complete with power supply and coils, from **£30.** Junior and Senior, **HALLICRAFTERS** S 27 VHF receivers 30-150 mc/s FM AM. S 38 VHF receivers A.C. D.C. 110-230, 550 kc/s -30 mc/s **£25.** Klystrons types 723 AB, 726A, 707A-B, CV129. Magnetrons 725A, 2J26, 2K22. Waveguide and components in stock. **BSR** Disc recording Amplifier, perfect order, **£30.**

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VALVES. 154, **10/6**; 6AG5, **10/6**; 117Z6, **12/6**; 6SH7, **6/6**; EF50, **8/6**; 955, 954, **6/-**; SG215, **6/6**; Pen 220A, **6/6**; TT11, **8/6**; VR 150, **10/6**; 42, **10/6.**

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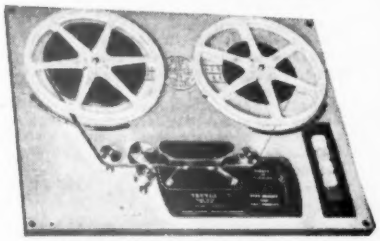

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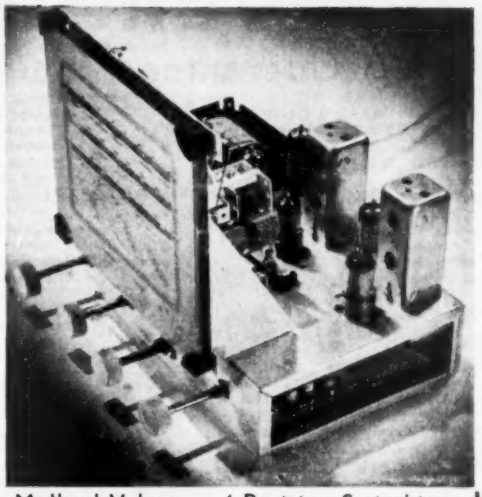

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Range 0/750 v. 200 ohms per v. Each	£1 2 6
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S.T.C. 125 v. 60 mA	4 6
S.T.C. 125 v. 100 mA	5 0
S.T.C. 125 v. 125 mA	6 0
S.T.C. 250 v. 250 mA	18 0

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250 v. 25 mA	6 6
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W/W. Mains Trans. Input 110/250 volts, output 325-0-325 80 mA, 6.3 v. 2.5 amps, 5 v. 2 amps	£1 1 0

PLESSEY midget type 230 volts input., output 230-0-230. 50 m a, 6 volt., 2.6 amps. screened primary, 12/6

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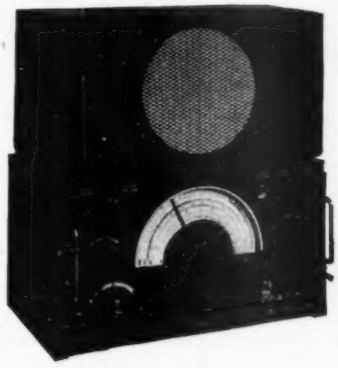

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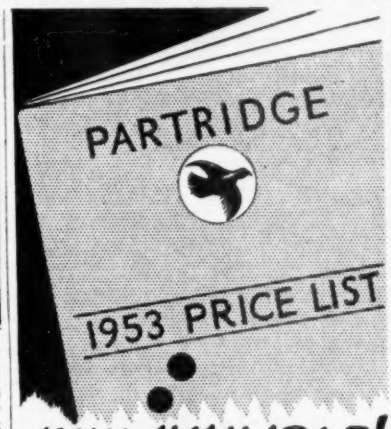

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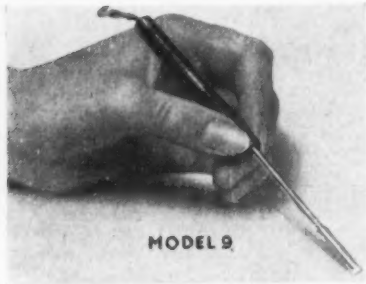

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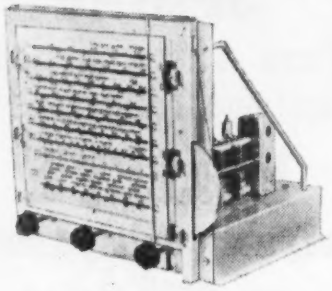

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12	2½	,,	16 6
12	2	,,	12 0
12	1	,,	7 6
6	1	,,	7 6
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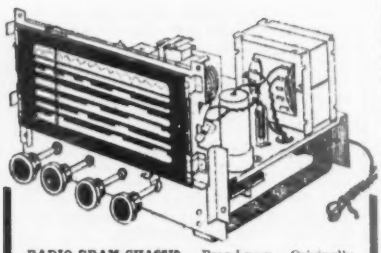

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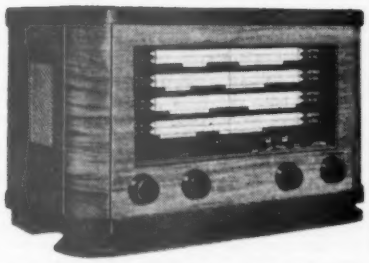

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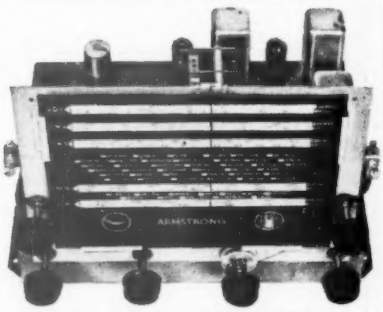

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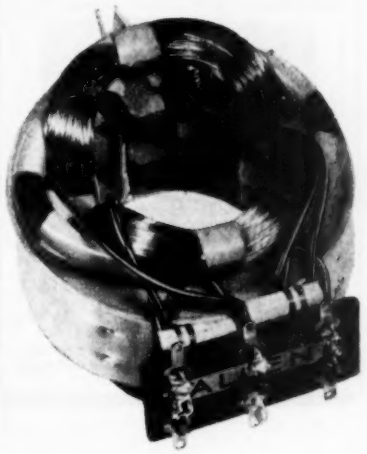

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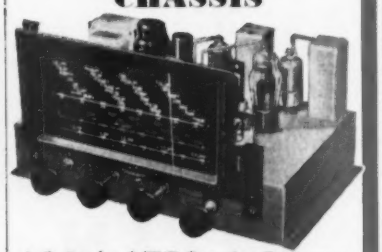

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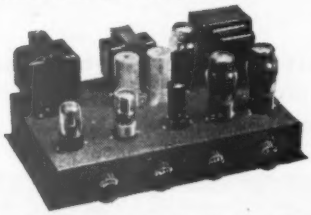

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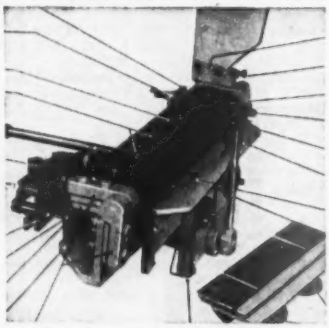

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REQUIRED, mechanical inspectors, experienced in the inspection of high quality scientific instruments; also electrical inspectors and testers, preferably with experience in small transformers and/or electronic equipment.—Apply by letter to E.M.I. Engineering Development, Ltd., Penleigh Works, Wells, Somerset.

GRADUATE physicist or electrical engineer is required for work on microwave measurements and test apparatus; previous experience desirable.—Apply in writing to the Staff Manager (Ref. RLO/335) Research Laboratories of The General Electric Co., Ltd., North Wembley, Middlesex, stating age, qualifications and experience. [9595

TEST equipment design engineer required by manufacturer of television receivers situated in N.W. London area; preference will be given to those applicants who have a knowledge of the underlying principles of test pattern generating equipment; apply in writing stating previous experience and salary required, to—Box 5063. [9657

ELECTRONICS technical writer required for compilation of technical reports, technical sales material and instruction and maintenance manuals on electronic equipment.—Apply, stating age, experience and salary required, to Personnel Officer, Saunders-Roe, Ltd., East Cowes, Isle of Wight, and quoting reference EW/10. [9673

SENIOR Engineer required to be responsible for development of electronic control systems and associated test apparatus; candidates should preferably have experience of airborne equipment; applications, which will be treated in strict confidence, to state age, qualifications and experience, quoting reference WW/SE.—Write, Box 4656. [9579

RADIO mechanics required by British Overseas Airways Corporation at London Airport; must be experienced in radio maintenance and/or overhaul; rates of pay 3/6 plus 3d bonus p.h., attracting proficiency pay up to 3d p.h., five-day, 44-hour week; possible shift work; write or call—Staff Superintendent (Recruitment), London Airport, Hounslow, Middlesex. [9661

RADIO service technician required by motor distributors in Luton; thorough technical knowledge of radio and servicing experience essential; successful applicant will be responsible for developing the department and its contact with traders and private customers; full details on application to—Dickinson & Adams (Luton), Ltd., Bridge St., Luton, Beds. Tel. Luton 3535.

ELECTRONIC laboratory assistants required by the English Electric Co., Ltd., Luton, for interesting circuit development work on defence projects; staff conditions; good prospects; further study encouraged; write, stating age, experience and qualifications, quoting Ref. 1066, to Central Personnel Services, English Electric Co., Ltd., 336-7, Strand, London, W.C.2. [9516

HATFIELD INSTRUMENTS Ltd., who are now expanding their laboratories, require Senior and Junior Electronic Engineers with experience in the repair and recalibration of high-grade radio and industrial laboratory equipment; apply in writing in the first instance, stating age, experience and salary required to—Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. [9606

PYE, Ltd., Cambridge.—Expanding television development programme has created vacancies for a number of senior television engineers with practical experience in the design of receiving and transmission equipment; the positions to be filled carry salaries in the region of £650 to £1,250 per annum.—Applications should be made to the Chief Television Engineer. [9563

ELECTRONIC Maintenance Engineer, attractive well-paid post for experienced man to maintain large R.F. production unit; applications will be considered only from those who have had full training in this sphere; the post is permanent and is situated near Colchester; all applications which should give full details of past experience will be treated in strict confidence.—Box 4699. [9582

THE PLESSEY Co., Ltd., Ilford, Essex, have vacancies for senior draughtsmen with experience of radio, television and associated equipment; good rates of pay and prospects of promotion; the positions are secure and successful applicants will be required to join the company's superannuation scheme.—Applications in writing to Personnel Manager, quoting reference WW/3. [9683

TROUBLE shooters required by a large electro-mechanical engineering company situated in the East London area; applicants should have had previous experience of telecommunications equipment; the positions are permanent and offer good rates of pay to men of first-class ability and excellent opportunities of promotion, please write, giving full details of experience and quoting WW/TS. to—Box 5066. [9662

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Camoridge, will shortly have vacancies for senior and junior engineers experience in V.H.F. design and engineering is essential, vacancies also exist for engineers with specialist experience in multi-channel V.H.F. Telephony; salary according to qualifications and experience. PLEASE apply, stating age, qualifications and experience to the Personnel Manager. [0209

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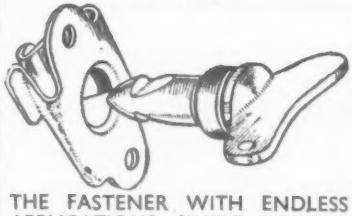

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ENGLISH ELECTRIC Co., Ltd., Luton, have a vacancy for an electronic engineer with drawing office experience, capable of translating laboratory ideas into engineered equipment; H.N.C. or equivalent an advantage but not essential; salary in range £500-£650 according to qualifications and experience.—Please reply quoting Ref. 1071 to Central Personnel Services, English Electric Co., 336/7, Strand, W.C.2.

ASSISTANT chief of test (electrical) required by light engineering factory, Stockport district, to take full responsibility for electrical test and inspection of radio and radar instruments; applicants must be familiar with A.I.D., C.I.A., A.S.R.E. inspection procedures; previous experience in similar position essential; good technical qualifications an advantage; write stating experience, age and salary required.—Box 4861. [9609

ELECTRONIC junior test engineer required with experience in motor control; National Certificate standard or equivalent, ex-H.M. Forces personnel with radar experience will be considered; permanent position, good working conditions, life insurance and pension scheme.—Apply, stating age, experience and qualifications, quoting reference 13.11.2, to the Personnel Superintendent, English Electric Co., Ltd., Stafford. [9393

RESEARCH engineers required, age 25-35; applicants should be of Degree Standard, preferably with Communications training and sound mathematical background; the work is experimental and concerned with various problems in electronics and acoustics.—Applications, stating age, previous experience and salary required, should be addressed to Personnel Dept., Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [9540

DEVELOPMENT engineers. International Aeradio, Ltd., specialists in equipment design for aviation service, due to expansion of development section at Bovingdon Airport near Watford, require junior and senior radio and telegraph engineers. Salary according to experience; single quarters provided, pension scheme, 5-day week, canteen facilities.—Please apply through Local Labour Exchange to Personnel Officer, 40, Park St., London, W.1.

SOUTH-EAST LONDON TECHNICAL COLLEGE, Lewisham Way, S.E.4.—Senior laboratory technician in radio and electronic department, responsible, with 3 technicians, for the maintenance of radio communication, electronics and radio service laboratories and the radio stores; salary £378 to £474, with additional increments for specified qualifications to £546; application forms from College Secretary for return within 14 days. (73) [9671

MCMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [9198

SKILLED radar mechanics urgently required by the Ministry of Supply for duties in connection with experimental electronic work at the Telecommunications Research Establishment, Malvern, and the Radar Research and Development Establishment, Malvern. Applicants should have completed an apprenticeship (or equivalent) in the radio or electronics industry, or have served an equivalent period in an appropriate trade category of H.M. Forces.

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TELECOMMUNICATIONS laboratory requires assistants for development work on carrier systems; good local facilities exist for study and there are prospects of advancement to higher technical grades; these posts are suited to those who have had experience of this type of equipment during national service, but are also open to those who have some experience of electronic circuits; age 21 upwards; salary from £7/6/6 per week to £8/16/6 per week.—Write Box 4806, giving full particulars. [9599

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T.C.C. invite applications for the positions of technical sales representatives in the radio, electronic and electrical industries; applicants should state, in detail, their age, qualifications, experience and salary required; only first-class men are being entertained; preferably those with previous experience in the industry.—Write (in confidence) to Sales Director, The Telegraph Condenser Co., Ltd., N. Acton, W.3.

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E., or possess equivalent qualifications together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week; contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [0230

DEVELOPMENT Engineers are required by the Electronics Division of Murphy Radio, Ltd., to work with a subsidiary Company at Ruislip, Middlesex; the work may be in the general field of electronics but special projects require personnel to work on ground and airborne aerial systems and telemetry; applicants should write in the first instance quoting "Engineers, Ruislip" giving full particulars of their experience and qualifications to—Personnel Department, Murphy Radio, Ltd., Welwyn Garden City. [9481

MECHANICAL designers are required for work in the research department of Marconi's Wireless Telegraph Co., Ltd., of Chelmsford, for work in connection with the design of experimental and prototype electronic equipment, embodying high precision mechanisms and stressed structures; pension scheme, five-day week, canteen facilities; please apply in confidence to—Central Personnel Services, Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, London, W.C.2, quoting reference 1068. [9608

PHYSICISTS and engineers required for development work on cold cathode tubes for use in communications. Applicants should possess a degree in physics or engineering or H.N.C. in electrical engineering, preferably with previous experience in similar work. The posts are pensionable and carry salaries commensurate with qualifications and experience.—Applications, with full details, are to be addressed in the first instance to the Managing Director, Hivac, Ltd., Greenhill Crescent, Harrow, Middlesex, and will be treated in confidence. [9570

DECCA RADAR, Ltd., require draughtsmen and junior draughtsmen for research drawing office, preferably experienced in any of the following fields: radar, radio and electronic circuits, electro-mechanical devices, light mechanical engineering; knowledge of workshop practice essential. Applicants must possess Ordinary National Certificate or equivalent, positions permanent and progressive; salaries based on A.E.S.D. rates.—Write, giving full details, to Chief Draughtsman, Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [0240

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B.B.C. requires a limited number of technical assistants, aged 21 or over, in operations and maintenance department, for service at transmitter, studio and television centres throughout the United Kingdom; knowledge of mathematics, electricity and magnetism to school certificate standard; experience in electrical or radio engineering an advantage; salary £360 p.a. with annual increments to £470 p.a. maximum; promotion prospects; application forms from—Engineering Establishment Officer, B.B.C., London, W.1 (enclosing addressed foolscap envelope). [9585

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, requires senior and junior electronic development engineers for work on guided weapons and like projects, particularly in the field of microwave and pulse applications, mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar type equipments, also required for the above projects; salary according to age, qualifications and experience; houses will be allocated to selected staff.—Apply by letter, stating age and experience, to The Personnel Manager (Ref. R.G.). [0239

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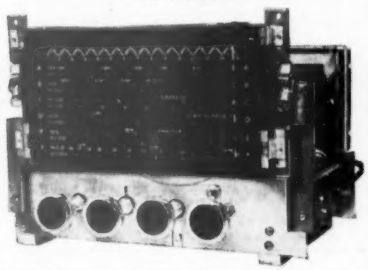

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EXPERIENCED electronic engineer required to be responsible for the exhaustive non-routine testing of precision electronic laboratory instruments in production, and for the design and construction of test equipment; the appointment carries considerable technical responsibility and requires a sound background of qualifications and experience; applicants should preferably have had previous instrument test department experience, and a theoretical knowledge to H.N.C. standard is required; salary in the range of £420-£520 p.a.—Applications should be made in writing to the Chief Engineer, Furzehill Laboratories, Ltd., Boreham Wood, Herts.

MURPHY RADIO invite applications for posts as Development Engineers in their electronics division. Applicants should have degrees in engineering or physics or equivalent qualifications preferably with some industrial experience and should be capable of undertaking original development work and of leading a design team. Reasonable prospects of housing for London applicants. Employment is permanent and pensionable and offers excellent opportunity of broadening experience. Applications giving full details of experience and qualifications may be forwarded in confidence to Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City. [9524

MINISTRY OF SUPPLY, Research Establishment, near Sevenoaks, Kent, requires electrical engineers for (1) development work on electrical components, (2) trials of experimental equipment, (3) development of electro-mechanical devices; quals., Higher School Cert. (Science) or equiv., but training in electrical engineering to standard of H.N.C. or degree may be an advantage; salary within ranges, Experimental Officer (min. age 26), £597-£754; Assistant E.O., £264 (age 18)-£555; women somewhat less; posts unestablished.—Application forms from M.O.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D.20/53A. Closing date 13 March, 1953. [9626

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MINISTRY OF SUPPLY, R.A.E., Farnborough, Hants, has experimental officer class vacancies in radio division, on development of electronic equipment, for radio frequency measurements, especially at centimetric wavelengths, and for other detailed technical investigations; quals.: Higher School Cert. (science) or equiv., but further training in Physics or Electrical Engineering to the standard of a degree, Grad. I.E.E., H.N.C. or final C. & G. Cert. in Telecommunications may be an advantage; knowledge of pulse circuitry, wave guide techniques, or radar equipments desirable for some posts; salary within ranges, experimental officer (min. age 26), £597-£754, assistant E.O. £264 (age 18)—£555; women somewhat less; posts unestablished; application forms from M.O.L.N.S., Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1, quoting D1/53A. Closing date March 10, 1953. [9590

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MINISTRY OF SUPPLY, Royal Aircraft Establishment, Farnborough, has experimental officer class vacancies in guided weapons department, for work on design, development and performance of new weapons and associated guidance and control systems; instrumentation of flight trials and investigation of trials results. Experience in any of these fields desirable:—light engineering development; hydraulic and servo mechanism design; electrical control devices; centrimetric radar techniques; design of light electrical, electronic or optical mechanisms; aircraft design, ballistics or aerodynamics; scientific computing or design of high-speed computing machines. Qualifications: Higher School Certificate (Science) or equivalent, but further qualifications in mechanical, electrical or electronic engineering, physics or mathematics may be an advantage. Salaries within ranges, experimental officer (minimum age 26), £597-£754; assistant experimental officer, £264 (age 18)-£555. Women somewhat less. Posts unestablished.—Application forms from M.O.L.N.S., Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1, quoting D 508/52A. [9571

MINISTRY OF SUPPLY, Telecommunications Research Establishment, Malvern, Worcs., requires electrical engineers and physicists for (a) the Scientific Officer grade (Ref. A5/53/A), and (b) Experimental and Assistant Experimental Officer posts (Ref. A6/53/A), for research and development work on radio and electronic equipment in the Radar, Physics and Engineering Departments. Work ranges from fundamental research on circuitry and physics of the solid state, to devising and developing in collaboration with industry electronic devices for the R.A.F. and Naval Aviation. Ample scope for initiative and originality over a very wide field concerned mainly with electronics. Qualifications for (a) 1st or 2nd class Hons. degree in Physics or Light Electrical Engineering, and for (b) Higher School Certificate (Science) or equiv., but further training in Physics or Electrical Engineering to standard of H.N.C., pass degree, etc., may be an advantage. Salaries within ranges: Scientific Officers, £417-£675; Experimental Officers (min. age 26) £597-£754; Assistant E.O. £264 (age 18)-£555. Women somewhat less. Posts unestablished but F.S.S.U. benefits may be available for S.O. grade.—Application forms from M.O.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting appropriate reference. Closing date 13th March, 1953.

ADMIRALTY.—Royal Naval Scientific Service, engineers and physicists (particularly with electronics) required for appointments in (a) Senior Scientific Officer and Scientific Officer grades (Ref. A246/52A) and (b) Senior Experimental Officer, Experimental Officer and Assistant Experimental Officer grades (Ref. A247/52A) in Experimental Establishments in London, Portsmouth, Weymouth areas and Scotland; candidates, British subjects, for (a) must possess first- or second-class honours degree in Physics or Engineering, or high professional attainments such as corporate membership of appropriate professional institution with suitable experience and responsibility and for (b) should possess one of the following qualifications:—University degree in science, engineering or mathematics, graduate membership of appropriate professional institution, Higher National Certificate, Final certificate of five-year grouped course in relevant subject at City and Guilds of London Institute or comparable institution, Higher School Certificate with mathematics or science as principal subject or equivalent qualification; S.S.O.s at least 26 years of age with at least three years' approved experience, London salary scale (men) £812-£1,022 per annum; S.O.s at least 21 years, £440-£707; S.E.O.s at least 35 years, £844-£1,075; E.O.s at least 26 years, £628-£786; A.E.O.s at least 17½ years, £274-£586; rates for women and posts in Provinces somewhat lower; starting salaries above minima may be granted according to age and experience; all appointments unestablished (with F.S.S.U. for S.S.O. and S.O.) but with some opportunities to compete for established posts; application forms from—M. of L. & N.S., Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1, quoting appropriate reference. [9589

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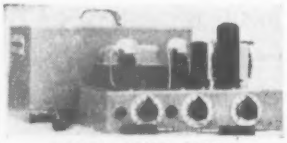

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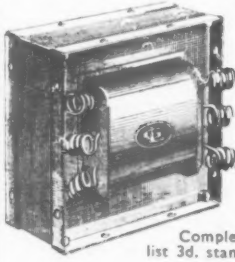

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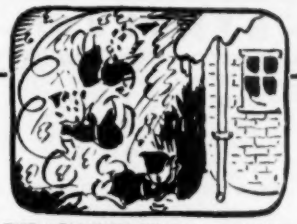

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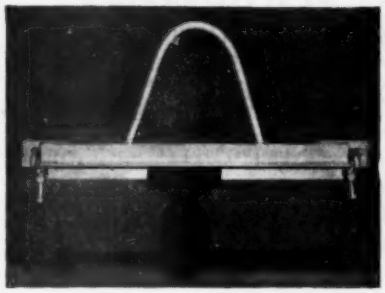

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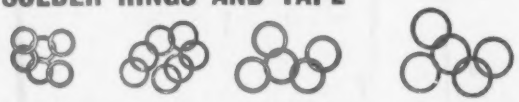

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